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Relationship Between Selected Postural Divergencies and Motor Ability

EVELYN A. DAVIES
University of California, Los Angeles

Abstract

One hundred women students majoring in elementary education at the University of California at Los Angeles were given the Scott Motor Ability Battery of tests. They were also given a subjective postural screening by three experts in this area. Most of the items included in the posture screening were judged while the student was in movement, walking or bending forward or sideward. Correlations were computed between selected postural divergencies found in subjects and their motor ability, using the mean of the divergencies marked by three expert judges and the subject's motor ability. The result of these correlations indicated that very little if any relationship exists between postural divergencies and motor ability for the subjects in this study.

It has been assumed by some physical educators that postural divergencies may inhibit or prevent a child from participating successfully in motor activities. It has often been said that balanced posture enables one to have graceful and efficient movement. If a person's body is out of alignment or is asymmetrical, he is not expected to have efficient movement patterns. There may be many reasons for this unbalanced or asymmetrical posture. It may be the result of psychological, physical, or psychosomatic difficulties. Regardless of the reason, many people feel that movement is affected by postures and that postures affect movement.

It is understood that the amount of influence postures have on movement depends upon many factors, such as the type and severity of deviation as well as the type and duration of movement. Many physical educators would agree that children with orthopedic defects such as those resulting from poliomyelitis, cerebral palsy, or similar diseases or conditions may have low motor ability, but the relationship between less severe postural divergencies and motor ability has always been questionable. For example, does a high shoulder or an increased thoracic curvature affect an individual's ability to throw a ball? Does an individual's leg alignment affect his ability to run?

This study was undertaken in an effort to obtain objective evidence relating to the problem of posture and movement. If there is definite relationship between an individual's posture and his general motor ability, then might it be possible to increase his motor ability by improving his posture?

Purpose of the Study

The purpose of this study was to determine the relationship between selected dynamic postural divergencies and general motor ability in college women.

Related Studies

Numerous postural tests and measurements have been performed with the subject in static positions. For the most part they have been concerned with specific measurements of individual body parts. Those measurements have been studied in relation to motor ability or motor educability.

In his study on Posture and Health, Deaver (2) used a combination of Roger's Physical Capacity Test (6), Brace Motor Ability Test (1) and the Harvard (4) system for measuring posture. From these factors, he determined the correlation of posture with physical efficiency to be .144. The Harvard system used silhouette ratings for posture measurements, taken with the subject standing behind a sheet.

Huelster (5) studied the relationship between bilateral alignment as it occurs in standing and in walking. This was accomplished by motion pictures of the subject initiating a walk from a stance. Measurements were then taken from selected frames. As part of her study, Huelster used these measurements to determine the reliability by body contour asymmetry at specific marked levels during standing and walking.

Fox (3) reported little relationship between shortness of the first metatarsal bone and function of the foot.

No studies have been reported which deal specifically with the relationship of dynamic postures and general motor ability.

Procedure

One hundred women students majoring in elementary education and enrolled in physical education activity classes at the University of California at Los Angeles, were selected as subjects for this study. Each subject was given a subjective posture examination by three judges, experts in the area of adapted physical education.

Items included in the posture examination were:

A. *Gait* (subject walking to and from judge)
   - Predominance of weight carried on one foot
   - Swings legs around instead of through
   - Feet everted
   - Ankles pronated
   - Weight on heels
   - Tibial torsion
   - Legs bowed
   - Knees knocked
   - Exaggerated hip swing
   - Exaggerated arm swing
   - Exaggerated bounce
   - Dragging or scuffing feet

B. *Hip prominent*
C. *Trunk list*
D. *Shoulders rigid*
E. *Shoulder high*

F. *Head tilt*
G. *Scapulae prominent*
H. *Rotation*
I. Restricted flexibility (subject standing, bending forward from hips, returning slowly to erect position, then bending from side to side as far as possible)
Lateral View (Judge standing at side while subject walks and then stands)
J. *Body lean*
K. *Shoulders forward*
L. *Thoracic curve*
decreased
increased
M. *Lumbar curve*
decreased
increased
N. *Hips forward*
O. *Abdomen protruding*
P. *Knees hyperextended*

They were selected by the judges as those things which might be observed while the subject was moving.

For the gait and over-all divergencies, a check mark was placed after each divergency noted. These check marks were totaled for each subject and the mean of the three judges' ratings was computed.

Both the decreased lumbar curve and restricted flexibility were rated as *marked* (minus three), *moderate* (minus two) and *slight* (minus one). These ratings were subtracted from the perfect score (ten) to obtain the score for each of these items.

Each subject was given the Motor Ability Battery for College Women described in Scott and French (7 & 8). This consisted of the Obstacle Race, Basketball Throw for Distance, and the Standing Broad Jump. T-scores were determined for each subject on the results of the battery and Pearson Product-Moment coefficient correlations were computed.

Analysis of Data

The correlation coefficients obtained for the 100 subjects indicate:

A. A low negative relationship between the mean of the judges' combined ratings for gait divergencies and motor ability (—.04).
B. A low positive relationship between the mean of the judges' combined ratings of over-all postural divergencies and motor ability (.22). This coefficient was significant at the 5 per cent level of confidence.
C. A low positive relationship between the mean of the judges' combined ratings of decreased lumbar curve and motor ability (.16).
D. A low positive relationship between the mean of the judges' combined ratings of restricted flexibility and motor ability (.05).

Conclusions

It appears that there is little or no relationship between postural divergencies as measured by the judges' ratings and motor ability for the subjects used in this study.

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(Submitted 11/29/56)

Relationship of Static Equilibrium to Ability in Motor Activities[1]

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Abstract

The purpose of this study was to investigate the relationship between static equilibrium and ability in gross motor activities. Static equilibrium was measured by the Miles ataxiameter. The subjects were selected on the bases of subjective ratings in motor ability in sport and rhythm, and "A" and "C" team skill classifications in the after-school sports program. The findings of this investigation support the hypothesis that there is a positive relationship between static equilibrium and ability in gross motor activities. The relationship was statistically significant at the 1 per cent and 5 per cent levels of confidence.

EACH DAY the teacher of physical education observes wide individual differences in motor abilities. Many factors contribute to this variability in motor performance, but it seems reasonable to assume that kinesthetic sensitivity may be especially important. Kinesthesis, as it is used in this study, refers to the sense which furnishes information about the position and movement of body parts, by means of sense organs located in the muscles, tendons and joints. Kinesthesis, or the movement sense, "underlies all kinds of skilled activities, such as speech, dancing and typewriting." (22, *p. 149*) Thus, kinesthetic sensitivity should be positively related to gross motor ability, as demonstrated in physical education activities. Since kinesthesis is the principal sensory system involved in standing erect, eyes closed, a measure of static equilibrium may be accepted as a measure of one aspect of kinesthetic sensitivity. The hypothesis is advanced that there is a positive relationship between static equilibrium and ability in gross motor activities. The purpose of this study was to investigate this relationship.

A static position is one in which an attempt is made to hold the body stationary. The standing position, however, cannot be a completely motionless one, owing to the arrangement of the body segments and the effect of gravity upon them. Hellebrandt (8, *p. 472*) refers to standing as "movement on a stationary base."

It must be recognized that there may be sources of stimuli other than kinesthetic which contribute to the maintenance of static equilibrium, eyes closed. According to Miles (12, *p. 158*) "the ataxiameter test as usually

[1]This study was made in partial fulfillment of the requirements for the degree of Master of Arts in Physical Education in the Graduate Division of the University of California, Berkeley, September 1955.

given is regarded as a measurement of motor control mediated by kinesthetic and tactual stimulations." Stagner and Karwoski (22, *p. 149*) state: "Kinesthetic and cutaneous stimuli are reunited in the cortex, although they travel separate paths in the spinal cord. This is important, functionally, since they co-operate closely in guiding motor adjustments." Miles (13) reports that severe anesthesia of the soles of the feet produces marked swaying, indicating that sensations arising from changes of pressure on different parts of the feet and of strain within the feet is of value in maintaining equilibrium. He suggests, however, that the cutaneous stimuli from tactual sensations arising in the soles of the feet are probably slight compared with the deep muscle sense due to pressure.

The stimuli from the non-auditory labyrinth must also be considered. Many authors do not differentiate between static and dynamic equilibrium in a discussion of the part played by the inner ear in the maintenance of equilibrium. There are, however, studies which indicate that it is doubtful if the slight changes in tilt during standing are sufficient stimuli to cause the labyrinth to initiate different compensatory movements (13), and that the receptors in the ankle joint probably play a more important role in body sway than do end organs in the labyrinth. (2, 13)

Review of Literature

In summarizing the literature, it would appear that the receptors in the labyrinth are insensitive to fine body movements and that vestibular function is of little importance in maintaining static equilibrium (2, 13). Many factors seem to influence static equilibrium, some of the more important ones being: vision, shoes, foot position, apprehension and distraction, and attention (3, 4, 5, 6, 13). Apparently, very little improvement occurs in body sway through practice (3, 4, 5, 7, 13). Different sensori-motor functions are measured by tests of static and dynamic equilibrium as evidenced by zero correlations between the two (7, 23).

Few investigations relating body sway to gross motor activities are reported in the literature. Adrian (21) found that a group of athletes and non-athletes, selected by varsity athletic participation and by measured ability in gross motor abilities, did not differ significantly in the fine motor ability represented by the Miles ataxiameter test. Generally, however, the athletes showed greater postural stability than the non-athletes, although the critical ratios indicated statistical insignificance. White (24) found a statistically significant difference in sway between a skilled athletic group and a poor athletic ability group. Patt (16) found body sway, used as a test of physical fitness, to correlate .43 with a fatigue test, which was the criterion selected for validation of the fitness tests.

Static balance has been measured by a one-leg balance on a balance stick 1 ft. x 1 in. x 1 in. or a one-leg floor balance. Findings which relate static balance to other kinesthetic tests show low inter-correlations between tests of kinesthesis, indicating that there is no justification for assuming a "gen-

eral" kinesthetic sensitivity, unless reference is made to the sum total of many specific abilities (19, 20, 25, 26).

Findings relating kinesthesis to motor performance indicate that there is a positive relationship between tests of kinesthesis and motor performance, although this relationship is not always statistically significant (1, 15, 19, 25, 26).

Other investigations of kinesthesis have been made by Phillips (17), McGrath (10), Meday (11), and Phillips and Summers (18), but the tests used by these authors did not include static balance. The kinesthetic tests used in these and in preceding studies measured the degree of retention of a kinesthetic image plus the accuracy of response to that image. More recently, Henry (9) and Mumby (14) experimented with kinesthetic tests of a dynamic nature, measuring the accuracy of a response to a changing situation. These studies also did not include the element of static balance.

Method and Procedure

APPARATUS

Static equilibrium was measured by the Miles ataxiameter. A detailed description can be found in reference 13, p. 318. In brief, the ataxiameter is a square, wooden frame, which when mounted, adjusts vertically to any desired height. A movement adder, calibrated in millimeters, is mounted under each corner of the frame. The subject, wearing a helmet, to which is attached a collar, stands under the center of the apparatus, directly facing the front corner of the frame. (See Figure I). Four threads pass from the collar, one

FIGURE I. Ataxiameter with Subject in Position.

to each of the movement adders. At the end of each thread is a five-gram weight. There is a simple method of setting, locking, and releasing all four adders. As the subject tries to maintain a stationary position, her sway causes the weighted threads to turn the adders, and the movement is indicated on the calibrated face of each adder. This measure of static equilibrium is a summation of anterior-posterior and lateral postural sway.

STANDARDIZED TEST PROCEDURE AND CONDITIONS

Standardized test procedure and conditions were established on two bases:

1. Preliminary Experimentation on Adults and Students. The results indicated that one practice and three test trials would give reliable results and that undue fatigue or boredom would be avoided.

2. Consideration of Factors Reported in the Literature. The following were controlled insofar as possible:

(a) Vision. Eliminated by use of a blindfold. (Sleep mask)

(b) Shoes. Subjects were required to wear the regulation tennis shoes worn for physical education.

(c) Foot position. The 45° foot position was selected. This position was the one most widely referred to in the literature.

(d) Rest between trials. Subjects were seated during the initial instruction period and between trials while the scores were recorded and the adders reset.

(e) Health. Good health, as evidenced by freedom from a cold and by not being immediately convalescent from an illness, was required of each subject. Good health status was confirmed by questioning each subject just prior to the testing. No student with a doctor's excuse from physical education was tested.

(f) Fatigue. No subject was tested if she had not had a minimum of eight hours sleep the previous night. No subject was tested immediately after her physical education class or after strenuous physical activity. No subject was tested if she "felt" fatigued.

(g) Menstruation. No subject was tested within three days of the onset of her menstrual period, during her period, or within three days of the cessation of her period.

(h) Apprehension. The writer was personally acquainted with all but a few of the subjects. This fact, coupled with that of having used the first trial as an adjustment period, helped to keep apprehension at a minimum.

(i) Effort. Subject was instructed that this was a test to see how still she could stand. She was to try to control the movement if she felt herself sway.

(j) Posture. Subject was instructed to stand in a relaxed and normal manner.

(k) Respiration. Subject was instructed to breathe normally.

(l) Attention. Controlled by instructing the subject to count silently the ticks of a metronome, set at the rate of one tick per second.

(m) Distraction. Kept at a minimum by the quiet location of the testing room.

A standardized testing procedure was followed with each subject.

SUBJECTS

Two criteria were used as the bases for the preliminary selection of subjects:

1. Subjective Judgments of High and Low Motor Ability. Seven staff members of the Girls' Physical Education Department at Sequoia High School were each given a list of all sophomore, junior, and senior girls and asked to indicate all girls who had high or low motor ability in sport, or high or low motor ability in rhythm. A letter of instruction and explanation was attached to each list. The staff was instructed to consider motor ability as a term which

encompassed "potential ability" as well as the present level of achievement. The results of the ratings were compiled. Four separate alphabetical lists were then drawn up: one each for high sport ability, low sport ability, high rhythmic ability, and low rhythmic ability, respectively. These lists included every girl judged high or low in sport or rhythm by at least one staff member during the first rating. These lists were then submitted to each staff member for a second rating. A record card was made out for every girl rated high or low in either sport or rhythm by at least two staff members.

2. *After-School "A" and "C" Team Skill Classifications.* The girls who participate in the after-school program are subjectively rated and classified into "A", "B", or "C" teams by the instructor, student captains, and student managers. "A" skill represents outstanding ability in the techniques and strategy of the sport; "B" skill represents above average ability; and "C" skill represents average or below-average ability.

The number of participants in after-school volleyball, basketball, and tennis is sufficient for at least three skill teams, and it is the opinion of the writer that the validity of the ratings in these three activities is high. For this reason, skill classifications were used only in these sports. The athletic point records for the past three years were reviewed. "A" and "C" teams were indicated on each girl's record card as well as the years during which she had participated in these activities. A card was made out for any girl who did not already have one as a result of the staff ratings.

Using the criteria of subjective motor ability ratings and the after-school team skill classifications, two groups of subjects were selected, one of high motor ability and one of low motor ability. Testing with the ataxiameter was started. These subjects were later rated by the staff on a seven-point scale, in order to identify the extremes in each group and to ensure the validity of the staff ratings.

Results and Discussion

RELIABILITY

The coefficients of correlation between trials 1 and 3, 1 and 2, and 2 and 3 were calculated by the product-moment method. The Spearman-Brown Prophecy Formula was applied to correct for a three trial length. Inspection shows the reliability of the test to be high. Results are shown in Table 1.

ANALYSIS OF JUDGES' RATINGS

Subjects meeting the criteria for preliminary selection were tested. These subjects were later rated by the staff on sport and rhythm on a seven-point scale, seven indicating very high ability and one indicating very low ability. The average rating for motor ability in sport was determined for each subject who had been judged by three or more judges. The average rating for motor ability in rhythm was calculated for each subject who had been judged by two or more judges.

There were 34 cases which had a mean sport motor ability rating of 6.0 to 7.0, and 34 cases which had a mean sport motor ability rating of 1.0 to

TABLE 1

Reliabilities of One-Minute Sway Trials and of a Three-Trial Test

Reliability	r-raw	r-corrected*
r13	.83	.94
r12	.82	.92
r23	.76	.90

*For a three-trial test.

3.75. There were 23 cases which had a mean rhythm motor ability rating of 6.0 to 7.0 and 23 cases which had a mean rhythm motor ability rating of 1.0 to 3.5. When the judges rated the subjects on a seven-point scale, no judge knew every girl well enough to rate her. This resulted in the subjects being rated by different combinations of judges. In order to determine whether any factor other than chance was effective in the judgments, a chi-square was calculated for each judge, using the number of cases rated by her in the high group and in the low group as the observed frequencies, and expected frequencies of 50-50. A chi-square analysis was calculated for each judge for both the sport cases and rhythm cases.

As a result of this analysis it was apparent that a selective factor was operating in both the sport and rhythm judgments of one judge. It was therefore necessary to equalize her judgments. This was accomplished in sport by throwing out 16 of her judgments in the high group, leaving 12, the same number as in her low group. Judgments #1 and #2, #27 and #28, and every other one between, were discarded. After discarding these ratings, all cases except one had an average rating of 6.0 - 7.0 and had been rated by three or more judges. The number of cases in the high motor ability sport group was thereby reduced to 33. Her judgments were equalized in rhythm by discarding 11 judgments in the high group, retaining three, arbitrarily selected as cases #5, #10, and #14. Discarding 11 cases resulted in five subjects not meeting the criteria of two or more judges and an average rating of 6.0 - 7.0. The number of cases in the high motor ability rhythm group was thereby reduced to 18.

T-RATIOS

After equalizing the judges' ratings, calculations were made to determine the statistical significance of the difference between the mean sway scores of the high and low motor ability extremes in both sport and rhythm. Results are presented in Tables 2 and 3.

A t-ratio of 2.69 for 67 cases in sport is significant at the 1 per cent level of confidence. A t-ratio of 2.65 for 41 cases in rhythm is significant at the 5 per cent level of confidence.

MEAN SWAY SCORES

Mean sway scores were determined for each step in the rating scale in the sport motor ability group. This group totaled 109 cases. Data are shown in Table 4. Inspection shows that the mean sway scores do not increase

TABLE 2

Comparison of Groups Rated High and Low in Sport Motor Ability

Item	High Group	Low Group
Motor ability ratings	6.0—7.0	1.0—3.75
No. of cases	33	34
Mean sway (mm)	1314.5	1597.9
σ	362.6	478.3
σ_m	64.2	83.3
t-ratio	2.69	

TABLE 3

Comparison of Groups Rated High and Low in Rhythm Motor Ability

Item	High Group	Low Group
Motor ability ratings	5.6—7.0	1.0—3.5
No. of cases	18	23
Mean sway (mm)	1205.2	1561.2
σ	321.1	510.6
σ_m	77.9	108.9
t-ratio	2.65	

TABLE 4

Mean Sway Scores of Sport Motor Ability Group According to Seven Steps of the Rating Scale[1]

Motor Ability Ratings		No. of Cases			Mean Sway in mm	
Very high	7.0	2	2		1041.5	
High	6.5—6.9	13	31	33	1325.7	1314.5
	6.0—6.4	18				
Above average	5.5—5.9	11	24		1322.3	
	5.0—5.4	13				
Average	4.5—4.9	9	18		1391.7	
	4.0—4.4	9				
Below average	3.5—3.9	3	12		1560.8	
	3.0—3.4	9				
Low	2.5—2.9	5	11	34	1398.8	1597.9
	2.0—2.4	6				
Very low	1.5—1.9	5	11		1833.5	
	1.0—1.4	6				
Total Cases		109				

[1]Complete data are on file in Hearst Gymnasium, University of California, Berkeley.

progressively from subjects with very high ability to subjects with very low ability. It is to be noticed, however, that there is a range of 792.0 mm from the lowest mean to the highest mean.

COMPARISON OF GROUPS ON BASIS OF AFTER-SCHOOL TEAM SKILL CLASSIFICATIONS

In the preliminary selection of subjects, 23 were not rated high or low by any judge, but qualified for this study on the basis of having been on three or more "C" teams in the after-school sports program. Later, when these subjects were rated on a seven-point scale, the mean rating of this group was 4.2.

There were 12 subjects who had been on "A" teams two-thirds or more of the times it had been possible to be on them in volleyball, basketball, and tennis. Thirty-six subjects had been on "C" teams two-thirds or more of the times it had been possible to be on them. Mean sway scores and mean ratings were obtained for these two groups. A t-ratio was calculated to determine the significance of the difference between the mean sway score of the "A" and "C" team groups. These data are presented in Table 5.

TABLE 5

Comparison of "A" and "C" Skill Team Groups in Motor Ability Ratings and in Mean Sway Scores

Item	"A"	"C"
No. of subjects on 2/3's or more possible teams	12	36
Mean sport motor ability rating—3 or more judges	6.04	3.96
Mean sway (mm)	1314.2	1550.7
σ	371.4	455.0
σ^m	112.2	77.0
t-ratio	1.72	

Since the difference between the mean sway score of the high and low motor ability groups has been established, the hypothesis being tested in this confirming experiment specifies the direction of the expected difference between the mean sway scores of the "A" and "C" groups. Therefore, a single-tailed t distribution is used, requiring a t of 1.68 for the five per cent level of confidence. Results show the t of 1.72 to be significant at the 5 per cent level.

The average rating by three or more judges of "A's" was 6.04, while that for "C's" was 3.96. It is the writer's opinion that this difference points toward the validity of both the judges' ratings and the after-school team skill classifications. It is to be expected that the mean rating of the "C's" would tend toward the average on the rating scale, for many of the girls who are very low in motor ability did not participate in the after-school sports program.

COMPARATIVE DATA ON HEIGHT AND WEIGHT

Previous studies on factors influencing static equilibrium have reported height and weight to be positively related to the amount of body sway. In

every instance, however, this relationship was reported to be low. The mean height and weight scores in both the sport and rhythm groups indicate that in this study there was no need to consider either height or weight a factor influencing the mean sway score. The largest difference in mean height was .27 inches in the rhythm groups, and in mean weight was 2.6 pounds in the sport groups.

COMPARATIVE STUDY OF SUBJECTS IN RHYTHM AND SPORT GROUP

This comparison was made to determine how many of the same girls were subjects in both of the high motor ability groups, and likewise, how many of the same girls were subjects in both of the low motor ability groups.

There were 18 cases in the high motor ability rhythm group. Thirteen of these were also cases in the high motor ability sport group. The other five cases had each been rated above average in motor ability in sport. There were 23 cases in the low motor ability rhythm group. Twenty of these were also subjects in the low motor ability sport group. Two of the other three cases had been judged average and one had been judged above average in sport motor ability.

FINDINGS

1. Reliabilities of the one-minute trials ranged from .76 to .83. Reliabilities of a three trial test were predicted to be .90 to .94.

2. The t-ratio between the mean sway scores of the high and low motor ability group in sport was 2.69, significant at the 1 per cent level of confidence. The t-ratio between the extremes in ability in the rhythm group was 2.65, significant at the 5 per cent level of confidence. The t-ratio between the mean sway scores of the "A" and "C" team group was 1.72, significant at the 5 per cent level.

3. The range in mean sway scores in the sport motor ability group was 1041.5mm to 1833.5mm. The mean sway scores did not, however, progressively increase for each step in the rating scale.

4. The similarity between the mean height and weight scores of the subjects in the high and low ability group in sport and rhythm indicates that height and weight were not factors influencing sway scores in this study.

5. Subjects who had been high in motor ability in rhythm tended to be high in motor ability in sport. A similar relationship existed in the low motor ability groups.

Summary and Conclusions

The purpose of this study was to investigate the relationship between static equilibrium and ability in gross motor activities. Static equilibrium was measured by the Miles ataxiameter. This measure is a summation of anterior-posterior and lateral postural sway. Trials were one minute in length. Trial one was used as a period of adjustment, and trials two, three, and four were recorded. The score of each subject was her total sway in millimeters of movement on trials two, three, and four.

Subjects were sophomore, junior, and senior high school girls, selected on the bases of subjective ratings in motor ability in sport and rhythm, and "A" and "C" team skill classifications in the after-school sports program. All subjects were rated on a seven point scale. There were seven judges and since no judge knew all subjects, judgments were equalized statistically. As a result, there were 33 cases of high motor ability and 34 cases of low motor ability in sport. In the rhythm group there were 18 cases of high motor ability and 23 cases of low motor ability. There were 12 subjects who had been on two-thirds or more of all possible "A" teams and 36 subjects who had been on two-thirds or more of all possible "C" teams in volleyball, basketball, and tennis in the after-school program.

It is concluded that the results of this investigation support the hypothesis that there is a positive relationship between static equilibrium and ability in gross motor activities. This relationship was statistically significant at the 1 per cent level of confidence in the sport motor ability group, at the 5 per cent level of confidence in the rhythm motor ability group, and at the 5 per cent level in the "A" and "C" team skill group.

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(Submitted 8/9/56)

Comparative Analysis of Eugene, Oregon, Elementary School Children Using the Kraus-Weber Test of Minimum Muscular Fitness[1]

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Abstract

In this study, 1,195 elementary school children were tested with the Kraus-Weber test of Minimum Muscular Fitness and compared with other geographical surveys. The Eugene group yielded a 38.1 per cent test failure. They were, by sex and age, superior to those in other published American studies. At no time, however, did any American sample score lower than the European youth. Of the 455 Eugene children who failed the Test, 78.7 per cent failed only one item. The flexibility item not only accounted for the greatest number of these failures, but at every age level caused the girls to appear more "muscularly fit" than the boys.

IN A PAPER delivered before the Medical Society of the State of New York, and later published in the *New York State Journal of Medicine*, Hans Kraus and Ruth P. Hirschland released the results of a study of minimum muscular fitness of elementary school children (4). The results showed that 56.6 per cent of American children failed the Kraus-Weber test (K-W) as compared to a significantly lower 8.2 per cent failure by European youth. Later, in a more complete report, Kraus presented the final figures generally associated with this survey: 57.9 per cent failure among American children and 8.7 per cent among European youth (5).

The implications of the Kraus findings presented a challenging problem to all interested in the state of physical fitness of American youth. Questions were immediately raised by physical educators as to the adequacy of the Kraus sample and of the validity of the K-W test. As a consequence, similar surveys were conducted in other geographical areas. One of the first follow-up studies was done in Iowa where 66.1 per cent of the children failed the test (3). A similar study in Indiana revealed 45.1 per cent test failure (6). Other studies have produced the following results: Springfield, Mass., 44-60 per cent; Pennsylvania, 49-57 per cent; India, 39.1 per cent; Saskawchawan, Canada, 31-57 per cent (1).

[1]This dual study was made in partial fulfillment of the Master of Science requirements at the University of Oregon. Acknowledgment is extended to Dr. H. Harrison Clarke for his assistance and advice throughout this study.

The main purpose of the present study was to provide additional statistics from another geographical area. Thus, with the present survey of minimum muscular fitness of Eugene, Oregon, elementary school children, additional information is provided relative to the fitness of youth throughout the United States. For this reason, the analysis of data has followed the same pattern as outlined in previous studies. However, in order to contribute certain information pertaining to the validity, the relative weight, and the discriminatory power of specific test items, additional analyses were made.

Procedure

The K-W test was administered to a random sample of Eugene, Oregon, elementary school children. Approximately 100 boys and 100 girls from each age, six to 12 inclusive, were selected by use of a table of random numbers (2). By use of this table, the sample can be considered representative of all school children of these ages in the city. The 1,195 pupils actually included in this survey constituted approximately 20 per cent of the total elementary school population.

The testers were certified for K-W testing competence by Donald K. Mathews, Washington State College, who had been approved by Kraus for this purpose.

Test Description

The K-W test is a six-item pass-or-fail battery. Brief descriptions of these items are as follows:[2]

1. *Abdominal Plus Psoas:* Ability to sit up from a supine position with legs straight, hands behind the neck, subject's feet held down by the examiner.
2. *Abdominal Minus Psoas:* Same as for Abdominal Plus Psoas only with knees bent and heels kept close to the buttocks.
3. *Psoas:* Ability to raise the legs 30° and hold for ten seconds from a supine position while the hands are held behind the neck and the legs are extended.
4. *Upper Back:* Ability to raise the trunk and hold for ten seconds. The subject begins the exercise from a prone position with a blanket under the abdomen, and hands held behind the neck, while the examiner holds the feet down and in contact with the table.
5. *Lower Back:* Ability to raise the legs and hold them in a raised position for ten seconds. The subject begins the exercise with hands on the table, blanket under the abdomen, with the examiner holding the upper back down in contact with the table.
6. *Flexibility:* Ability to bend over slowly from an erect position and touch the finger tips to the floor without bending the knees.

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[2]A complete description of the K-W test can be found in the May 1954 issue of the *Research Quarterly*, pp. 178-188. Reprints of this article, "Minimum Muscular Fitness Tests in School Children," by Ruth P. Hirschland and Hans Kraus, M. D., are available from AAHPER at 20¢ each.

Definition of Terms

The data from this survey were analyzed by sex and age and compared with the findings from similar studies in other geographical areas. For each comparison, the specific terms which are uniquely associated with the K-W test have been used. The definitions of these terms are as follows: *Per Cent Test Failure:* This percentage is obtained by dividing the total number of test failures by the total number in the sample, and then multiplying the product by 100. *Per Cent Incidence Failure:* The incidence percentage is found by adding the number of flexibility, abdominal, psoas, and back failures, and then dividing this sum by the total number tested. *Per Cent Incidence Weakness:* This percentage is calculated by the same method as that used in determining the Per Cent Incidence Failure, except the flexibility item is eliminated from the count. *Per Cent Flexibility Failure:* This figure is found by dividing the total number of flexibility failures by the total number of tests administered, and then multiplying the product by 100. *Item Analysis:* Item analysis is obtained by tabulating the number of failures under each test item to show where the greatest number and percentage of failures exist.

Analysis of Data

PER CENT OF TEST FAILURE

With the exception of the European 8.7 per cent, the 38.1 per cent test failure for the Eugene group was the lowest for any area yet reported. Other American samples were as follows: Eastern Seaboard, 57.9; Iowa, 66.1; Indiana, 45.1; Springfield, Mass., 44.0-60.0; Pennsylvania, 52.0-57.0. The two foreign studies of Saskatchawan, Canada, 30.0-57 per cent and India, 39.1 per cent resulted in per cent test failures comparable to the surveys in the United States.

Table 1 shows the Eugene children to be superior to all other samples in all age groups, except age eight, when they were grouped by age and compared with other samples. A second finding was that, while Kraus' eastern seaboard sample maintained a consistent increase in test failures from ages eight to 12 years, both the Eugene and Indiana groups failed to follow this trend. Kraus concluded from his survey that the children leave the elementary

TABLE 1

Comparison of Total Per Cent of Test Failures at Different Age Levels in Eastern Seaboard, Indiana, and Eugene Groups

Group	Age						
	6	7	8	9	10	11	12
Eugene	52.9	36.3	41.9	37.1	29.4	33.1	41.9
Eastern Seaboard	54.0	55.0	52.0	54.0	58.0	62.0	65.0
Indiana	54.1	44.9	36.0	40.8	50.4	44.5	44.9

schools in a lower state of muscular fitness than when they entered. Other studies, however, indicate that pupils are in better physical condition, based upon the K-W test, when they leave the elementary schools than when they entered them.

In addition to the above findings, the Eugene boys had an average failure rate of 46.4 per cent, as compared to 29.8 per cent for the girls. This particular result was also obtained in the Indiana and Iowa studies. A further comparison of the per cent test failures by age showed the Eugene girls had a consistently lower percentage of test failures from ages six to 12 than did the boys.

In a study by Whittle (7) during 1955, the physical education programs at some of the Eugene elementary schools were evaluated with a modified form of the LaPorte Score Card. The tabulations in Table 2 revealed that the boys and girls in the schools with good physical education programs had nearly 15 per cent fewer failures than did those with poor programs.

TABLE 2

Comparison of K-W Test Failures with Type of Physical Education Program in Eugene Elementary Schools

Schools	Boys	Girls	Total
Good Program	(*% failed*)	(*% failed*)	(*% failed*)
E	44.4	18.9	31.5
I	38.9	25.0	31.9
Poor Program			
A	50.0	20.6	36.1
G	44.4	36.1	40.3
N	51.3	48.4	50.0
R	56.5	58.3	57.4

PER CENT OF INCIDENCE FAILURE

The total incidence of failure calculated for the Eugene group was 48.1 per cent. This figure was lower than the 53.9 per cent reported by the Indiana study and considerably lower than the 80.0 per cent found by Kraus in his Eastern Seaboard sample. This latter group obviously contained a larger percentage of multiple failures than did either of the other two studies.

Table 3 reveals that when the children from the various studies were grouped by age and compared, the Eugene children were superior to the other American samples at all ages but eight and 12. However, when compared to the European children, the per cent incidence of failure was consistently higher for all surveys of children in the United States.

A further subdivision of these incidence figures was made to compare the rate of failure between the boys and girls. The girls' rate of 39.2 per cent was found to be nearly 20 per cent lower than the boys' rate of 57.1 per cent. This, by itself, produced a rather distorted picture, as it implied that the girls are more muscularly fit than the boys. It should be remembered, how-

TABLE 3

Comparison of the Per Cent Incidence Failures at Different Age Levels in the Eugene, Indiana, Eastern, and European Groups

Group	Age						
	6	7	8	9	10	11	12
Eugene	74.3	49.3	51.8	45.1	35.6	39.3	48.6
Eastern	76.0	78.0	66.0	69.0	78.0	117.0	91.0
Indiana	71.1	53.4	43.4	58.1	56.3	50.2	49.3
Europe	9.8	7.8	6.9	18.6	16.3	15.8	11.6

ever, that these figures represented a summation of individual test failures. This fact become an important consideration in a later analysis.

PER CENT INCIDENCE OF WEAKNESS

The per cent incidence of weakness for the Eugene group was 24.2 per cent. For the other surveys, the percentages were as follows: Eastern Seaboard, 35.7; Iowa, 34.8; Indiana, 17.7; and Europe, 1.1. The fact that children in the United States were found to have numerous multiple weakness failures revealed a major reason why they did so poorly on the K-W test, that is, in comparison with the European children.

A comparison of the incidence of weakness failures for Eugene, Eastern Seaboard, Indiana, and European children is shown in Table 4. All samples represented in the table followed the same downward trend from ages six to eight years. Then, for some reason, the Eastern Seaboard sample showed an upward swing until this age of 12 was reached, and Eugene samples maintained a consistent decline with age. As shown in Table 3, the per cent incidence of failure for the Eastern Seaboard group increased more rapidly than the per cent of test failures shown in Table 2. This finding represents an increase in multiple failures of the test items, but does not necessarily indicate an increase in the per cent of weakness failures. The apparent discrepancy among the multiple failures in these latter ages is a direct result of many flexibility failures combined with a few weakness failures.

When the incidence of weakness failures were compared by sex, little difference was found between the boys' 23.5 per cent and the girls' 35.2 per cent weakness failure.

TABLE 4

Cormparison of the Per Cent Incidence of Weakness Failures at Different Age Levels in the Eastern, Indiana, Eugene, and European Groups

Group	Age						
	6	7	8	9	10	11	12
Eugene	52.9	27.9	28.8	20.2	12.8	13.8	13.5
Eastern	39.0	37.0	27.0	30.0	30.0	40.0	36.0
Indiana	40.4	20.8	12.3	15.7	11.2	8.8	7.2
Europe	5.0	3.7	2.0	2.9	1.7	1.6	7.9

PER CENT FLEXIBILITY FAILURE

A similar situation to that which existed under the weakness failures appeared in the analysis of the flexibility item. The Eugene score of 23.9 per cent was the lowest reported failure found in the United States. The next lowest was Indiana (36.3 per cent), then Eastern Seaboard (44.3 per cent), and finally, Iowa with a failure rate of 56.9 per cent. All were significantly higher than the 7.8 per cent flexibility failure found in the European group.

Several facts were disclosed when the flexibility failures were analyzed by age. Reference to Table 5 reveals that the Eugene children registered at least 10 per cent lower on the flxibility item at each age level than the other samples in the United States. At no age, however, did any of the latter approach the low percentage of European figures. This table also indicates that inflexibility increases with age.

TABLE 5

Comparison of Per Cent Flexibility Failures at Different Age Levels in the Eugene, Eastern, Indiana, and European Groups

Group	Age						
	6	7	8	9	10	11	12
Eugene	21.4	21.4	22.5	29.9	22.8	25.5	35.1
Eastern	33.0	40.0	40.0	39.0	44.0	40.0	35.0
Indiana	30.7	32.5	31.1	36.1	45.1	41.4	42.0
Europe	4.6	3.2	6.1	10.1	11.0	11.7	9.8

The per cent of flexibility failures were further analyzed by sex, and again a marked superiority was revealed by the girls. Their rate of failure was only 14.0 per cent, as compared to 33.9 per cent for the boys. This difference in the rate of flexibility failures was chiefly responsible for the situation in which the girls appeared more muscularly fit than the boys. When, however, the flexibility failures were combined with the other failures, the weight of the flexibility item was not revealed.

Thus far, the analysis of the data have shown the girls to be superior to the boys in all but the per cent incidence of weakness failures. A further subdivision for each test, by age and sex, was then attempted to find a possible answer to the differences between the performance of the boys and girls.

ITEM ANALYSIS BY SEX AND AGE

Several findings were revealed from the Eugene data when the failures for each test item were analyzed by sex and age. With the exception of the eight-year-olds, the girls' scores were at least 14.0 per cent lower than the boys' on the flexibility test. Similar results were found in the Iowa and Indiana studies. In the abdominal minus test, Eugene boys showed a rapid decrease from 34.3 per cent failure at age six to 4.6 per cent at age 12. The failure rate of the Eugene girls followed the same pattern, decreasing from 40.0 per cent at age six to 9.6 per cent at age 12. The same trend was found in both the Iowa and Indiana studies. It should be noted that the increasing failures

in the flexibility test and the decreasing failures in the strength test, when added together, counteracted each other, to the extent that there appeared to be no gain in muscular fitness with an increase in age.

To further clarify the extreme influence the flexibility item exerted in the test battery, it was necessary to isolate the total test failures by sex into those failing one, two, three, or four test items. These failures are presented in terms of percentages in Table 6. The tabulations in this table reveal that of 455 students who failed one or more of the six items, 78.7 per cent failed on only one test item.

A significant finding pertaining to the analysis of these data is contained in Table 7 and Figures I and II. At every age level, the boys failed in flexibility more often than did the girls. The greatest difference occurred at age 11, where the 90 per cent failure by the boys was 17.9 per cent above the 72.8 per cent failure registered by the girls. Under the abdominal minus test, however, the opposite findings appeared. None of the boys failed this test item, while 28.6 per cent of the girls failed it. Figure I emphasizes the importance of the flexibility item in determining the total test failure. Fifty per cent more failures were rendered in the flexibility item than any other item in the test battery. An inspection of Figure II shows why so much controversy has arisen over this item. Nearly twice as many boys (59.4 per cent) failed the flexibility item than did the girls (33.0 per cent), while the opposite results were found under the abdominal minus psoas test, which 35.2 per cent of the girls failed, in comparison to 18.6 per cent of the boys.

TABLE 6

Per Cent of Boys and Girls at Each Age Level in the Eugene Group Who Failed the Total Test by One, Two, Three, or Four Test Items

Age	Sex	Total (% *failed*)	One Item (% *failed*)	Two Items (% *failed*)	Three Items (% *failed*)	Four Items (% *failed*)
	Boys	58.6	73.2	21.9	4.9	0.0
	Girls	47.1	57.6	36.4	3.0	0.0
7	Boys	46.1	66.0	27.7	4.3	2.1
	Girls	26.2	80.6	15.6	3.8	0.0
8	Boys	50.5	89.1	10.9	0.0	0.0
	Girls	34.0	76.5	11.8	5.9	5.9
9	Boys	40.0	84.1	11.4	2.3	2.3
	Girls	34.0	80.0	20.0	0.0	0.0
10	Boys	34.8	77.4	22.6	0.0	0.0
	Girls	24.2	86.4	9.1	4.5	0.0
11	Boys	47.8	90.7	7.0	2.3	0.0
	Girls	20.8	72.8	22.7	4.5	0.0
12	Boys	55.8	87.5	4.8	4.2	0.0
	Girls	22.6	85.7	14.3	0.0	0.0
Total						
	Boys	46.4	80.8	15.9	2.6	.7
	Girls	29.8	75.4	19.6	3.4	1.7
	Both	38.1	78.7	17.4	2.9	1.1

TABLE 7

Number and Per Cent of Boys and Girls at Each Age Level in the Eugene Group Failing One Item in the Test Battery

Age	Sex	% Flexibility Failure		% Abdominal Failure		% Remaining Item Failure	
		No.	%	No.	%	No.	%
6	Boys	13	29.3	15	36.6	3	7.3
	Girls	3	9.1	15	45.5	1	3.0
7	Boys	23	50.5	7	14.9	1	2.1
	Girls	7	26.9	9	34.6	5	19.2
8	Boys	24	52.2	16	34.8	1	2.2
	Girls	12	35.3	12	35.3	2	5.9
9	Boys	29	65.9	8	18.2	0	0.0
	Girls	14	40.0	13	37.1	1	2.8
10	Boys	23	74.2	1	3.2	0	0.0
	Girls	11	50.0	8	36.4	0	0.0
11	Boys	33	76.7	5	11.6	1	2.3
	Girls	9	40.9	4	4.5	3	13.6
12	Boys	20	83.3	0	0.0	1	4.2
	Girls	3	42.9	2	28.6	1	14.3
Total							
	Boys	164	59.4	52	18.6	7	2.6
	Girls	59	33.0	63	35.2	13	4.7
	Both	223	49.0	115	25.3	20	4.4

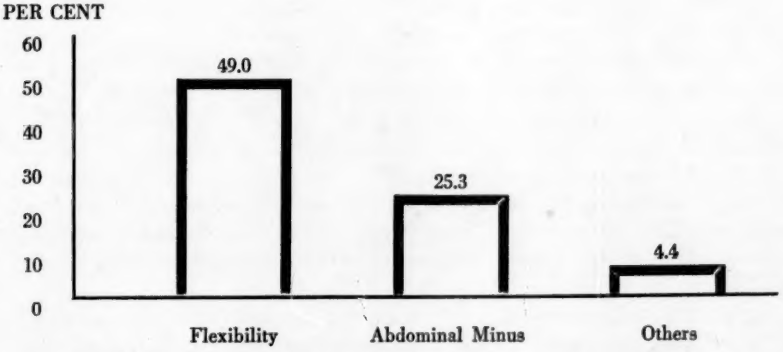

FIGURE I. Per cent of Eugene children who failed one item in the K-W Test.

When the flexibility item was removed from the battery the total test failure was reduced from 38.1 per cent to 19.4 per cent, with the girls failing a greater percentage of strength items than the boys.

Summary and Conclusions

The Kraus-Weber test was administered in 1956 to a random sample population of 1,195 elementary school children of Eugene, Oregon.

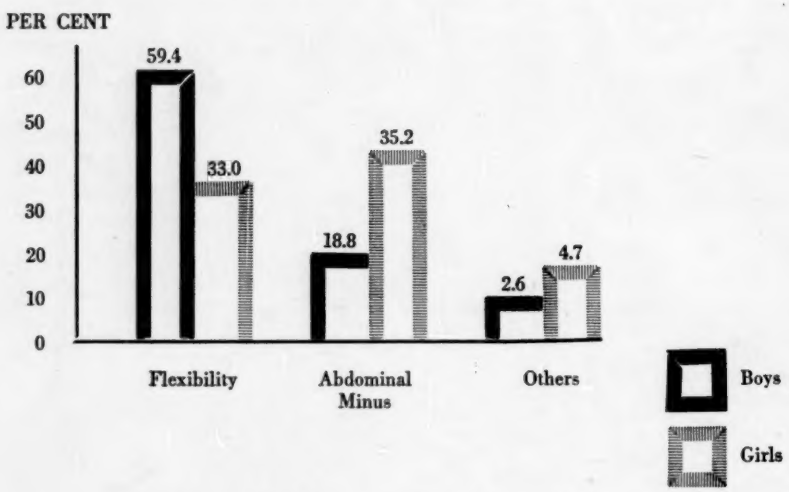

FIGURE II. Comparison of boys and girls who failed the K-W Test by one item.

Of the children in the Eugene sample, 38.1 per cent failed one or more of the test items. This percentage of failures was lower than had been obtained in other published surveys in the United States and considerably lower than the original Kraus' findings of 58.7 per cent.

The girls were substantially superior to the boys at all age levels. Similar results were reported from surveys of Iowa and Indiana children. The reason for this difference was revealed to be due largely to the difference in failures in the flexibility test, as 33.9 per cent of the boys failed this test item while only 14.0 per cent of the girls failed it. When the flexibility item was removed from the test battery, the total test failure was reduced from 38.1 to 19.4 per cent.

Of the 455 children who failed the test, 78.7 per cent failed only one item; 17.4 per cent, two items; 2.9 per cent, three items; and 1.1 per cent, four items.

For both sexes, there was a decrease in strength failures at each increased age level; at the same time, there was an increase in flexibility failures at each increased age level.

In a study by Whittle, several of the Eugene elementary schools were classified as having good or poor physical education programs. In studying the K-W results for those schools included in both studies, the children in the schools with good programs had almost 15 per cent fewer test failures than did those with poor programs.

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(Submitted 10/15/56)

Effects of Isometric and Isotonic Exercises on Elbow Flexor Muscle Groups [1]

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Abstract

The purpose of this investigation was to study the effects of isometric type exercises. One hundred and twenty Springfield College male students were tested, half exercising isometrically and the other half isotonically. The 60 subjects in the Isotonic Unit exercised to exhaustion on the Kelso-Hellebrandt ergometer with a weight load equal to 3/16 of their maximum strength. The subjects in the Isometric Unit exercised by exerting maximum effort in three consecutive six-second pulls on a strap. The two exercise units were divided into four groups, each containing 15 subjects. The respective groups exercised two, three, four, and five times a week over a period of four weeks.

The following results were obtained: 1. No common regression line was found in the eight groups, indicating the strength changes were peculiar to the individual, regardless of exercise frequency; 2. The isometric type exercise caused a greater number of subjects to significantly gain in strength; and 3. The five-day-a-week exercise program was most beneficial in terms of strength gains.

DESPITE THE NUMEROUS articles appearing in the literature relative to body building activities, Tanner (6) points out the lack of quantitative information concerning such problems as the type and intensity of exercise most efficient in producing muscular growth.

The amount of muscle hypertrophy seems related to individual differences. Kohlrausch (5) found that growth in muscle girth is related to body type. The very thin subjects responded less to strenthening exercises even though they continued to improve. The athletic type increased the most.

Herxheimer (2) in studying the effects of muscle training on adults found most marked muscular atrophy in those men who were underweight at the beginning of the training periods. In another study, Herxheimer, as a result of findings on boys in a summer athletic program, postulated that during periods of rapid growth in body length, exercise had less effect on muscle hypertrophy than in periods when the tendency toward growth in diameter predominated.

[1]This investigation was supported in part by funds provided for biological and medical research by the State of Washington Initiative Measure No. 171.

More recently, Muller and Hettinger (3) studied static contractions in which intensity and duration were easily measured to ascertain effects on muscular hypertrophy. Exercises were performed with nine male subjects in a series of 71 tests which lasted over a period of 18 months. The authors examined the influence of different kinds of exercise, various strength exercises, different durations of exercises and the frequency of daily exercise upon the increase of the maximal isometric strength of muscle contractions. All training was performed by pulling and holding a predetermined amount of tension against a dynamometer. On Saturday, maximal strength was measured. The higher reading of two trials was recorded. Sunday was a day of rest, while Monday through Friday was devoted to training sessions in which the intensity of contractions, the length of time held, and the number of practices per day were varied. On the average, the increase of maximal muscle strength per week was five per cent of the starting value, i.e., the value before the beginning of the training sessions. Muscle strength increases were more rapid with increasing intensity of training loads up to about two-thirds of the maximal strength.

Beyond this, increases in the training load had no further effect. One practice period per day in which the tension was held for six seconds resulted in as much increase in strength as longer periods and more frequent practices. These authors concluded static exercise work permits a rapid muscle training with lowest expense of time and energy.

Statement of the Problem

The purpose of this study was to examine the effectiveness of various frequencies of training programs upon the changes in strength of the elbow flexor muscle group. A second problem was to study the effectiveness of an isotonic contraction and an isometric contraction in terms of strength changes.

Research Procedures

Isotonic Exercise. For performing the isotonic exercise, the Kelso-Hellebrandt ergometer was used. The load carried by each subject was three-sixteenths of the elbow flexor strength at the time of each exercise, which was obtained by using Clarke's Cable Tension Strength Test (1) for the elbow flexor muscle group. The unit of measurement was read in tension pounds from the tensiometer and then converted to pounds by means of a calibration chart. In this way, the subject's load on the ergometer during the training program remained proportionately the same for each exercise. Thus, in addition to the isotonic exercise on the ergometer, the subjects in this group performed one isometeic contraction of maximal effort with each visit to the laboratory, so that the proper load proportion could be placed on the ergometer.

The subject exercised until exhaustion, that time being when the individual could no longer raise the weights sufficiently to cause a distance meter in the tower of the ergometer to register. Cadence for the exercise was maintained by an electric metronome—one second for flexion and one second for

extension. Exhaustion was usually accomplished in from two to two and one-half minutes, or 60 to 75 complete movements.

Isometric Exercise. In this training program, Clarke's Cable Tension Strength Test for the elbow flexor muscle group was employed, both in taking the strength measurement and as a means for the isometric exercise. The subject, assuming the position described by Clarke, exerted three consecutive, six-second maximal contractions against the strap and cable arrangement. Time was counted audibly for each of the three contractions and the unit of measurement was recorded in pounds pull.

Isotonic and Isometric Exercise Schedule. For convenience of presentation, the subjects exercising on the ergometer will henceforth be referred to as the Isotonic Unit, while subjects exercising on the strap cable assembly will be called the Isometric Unit. Two types of muscular training were used in this study, one involving predominantly an isotonic contraction and the other an isometric contraction. Four groups of 15 subjects each made up the "Isometric Unit."

The subjects were Springfield College male students selected at random. Strength of the elbow flexor muscle group was used as a basis for equating the eight groups.

Each of the four groups within the two Units trained over a four-week period in the following manner. Group I exercised twice a week, Group II exercised three times a week, Group III exercised four times a week, and Group IV exercised five times a week. For the "Isotonic Unit," the training consisted of exercising on the Kelso-Hellebrandt ergometer, while the "Isometric Unit" trained by exerting three consecutive six-second maximal static pulls on a strap.

Statistical Analysis of Data

The basic hypothesis of this experiment is that a given frequency of exercise will result in a rate of muscular development for the individual depending upon which exercise group he falls into. The four frequencies of exercise will give 60 individual regression lines and four group regression lines for each Unit. Thus the rationale involved in the statistical solution of this problem is that in each group there exists a common regression line which accounts for more of the variance than does the deviations of the individual regression lines from this average regression. In this analysis then, significance between group regression lines (rate of improvement of a given group) will be tested to determine whether one exercise frequency results in a greater strength gain than does another. The unit of measurement in all cases is in terms of pounds pull as recorded by the tensiometer.

However, one must take cognizance of the fact that the individuals may not, within an exercise group, all improve at the same rate, i.e., a common regression. Despite this variability, it seems pertinent to consider the problem as one of an analysis of variance among regression coefficients as follows (4):

Source of Variation	*d.f.*
Common Regression	1
Between Exercise Groups (E.G.)	3
Between Individual Regressions Within E.G.	56

This analysis may be achieved by first obtaining the following within exercise group analysis:

Source of Variation	*d.f.*
Exercise Group Regression	1
Between Individuals Within E.G.	14
Deviations from Individual Regressions	90, 150, 270

These are then pooled to give the analysis shown above. Despite the obvious variability in the individual regressions, as seen in the individual analyses, it seems best to pool the "Between Individuals Within Exercise Group" sums of squares and use this as a basis for testing the differences among the group regressions.

Isotonic Exercise Unit. Table 1 contains the results of the analysis of variance of errors of estimate from the "Average Regression Within Groups" for the subjects exercising on the Kelso-Hellebrandt Ergometer twice a week. To determine whether a common regression exists for this group, the sums of the squares of the deviations of individual regressions from the exercise group average regression have been computed and divided by 14° of freedom to establish the variance estimate. Also, the deviations from the individual

TABLE 1

Analysis of Errors of Estimate from Average Regression Within Groups: Two Days Per Week Isotonic Contraction

Source of Variation	Degrees of Freedom	Errors of Estimate	
		Sum of Squares	Mean Square
Between Means of Individuals	14	31503.41	
Average Regression	1	977.35	977.35
Deviation of Indiv. Reg. from Exercise Group Average Regression	14	818.08	58.43
Deviation from Individual Regression	90	1362.95	15.144
			F = 3.86

regressions sums of squares were computed and divided by 90° of freedom to arrive at an estimate of variance, the F ratio equals 3.86 which is significant beyond the .01 level of confidence. On the basis of this analysis, we may conclude that no common regression exists within the group. Furthermore, each subject is reacting to the training in an individual manner.

In like manner, the analysis of errors of estimate from the average regression within groups was computed for each of the groups in the Isotonic Unit, exercising 3, 4, and 5 days each week. In every instance, the F tests resulted in significance beyond the .01 level of confidence, indicating that no common regression exists within the groups.

As a result of these findings, it is not feasible to test for significance in terms of rate of improvement between the groups as originally planned, for there is no common regression peculiar to a given exercise group. In each of the four groups, the deviations of individual regressions from the group regression account for more of the variance than do the deviations from the individual regressions, implying of course that the rate of change in strength is peculiar to the individual.

Individual Strength Changes in the Isotonic Unit. To determine whether or not the individual subjects experienced a significant gain in strength, the sum of squares owing to regression, as well as the sum of squares of the deviations from the regression, were computed. The F test with appropriate degrees of freedom was applied in the analysis of each of the 60 subject's scores. Table 2 contains a summary of these findings. From the table it can be observed that of the two and three days a week exercise each contains nine subjects with significant strength gains, while six subjects remain the same. The four and five day a week exercise groups resulted respectively in 11 and 12 subjects significantly increasing in strength of the elbow flexors. To illustrate the effect of the various exercise prescriptions on the subjects, regression equations for each of the 15 individuals in the four groups were computed.

TABLE 2

Summary of Individual Strength Changes for the Four Exercise Groups: Isotonic Contractions

Exercise Groups	No. of Subjects Gained Strength[1]	No. of Subjects Didn't Gain Strength
2 days per week	9	6
3 days per week	9	6
4 days per week	11	4
5 days per week	12	3
Total	41	19

[1]Significant at or beyond the .05 level of confidence.

Figure I contains the 15 regression lines of the group exercising twice a week on the Kelso-Hellebrandt ergometer. It can be observed from this graph that 11 of the subjects exhibit an upward trend toward strength gains. Actually, only nine of these gains are significant, as can be seen from Table 2. Three of the regression lines indicate a downward trend, whereas in actual test of significance, six subjects failed to increase in strength as a result of the exercise training. The large spread of lines and lack of unity appears to bear out the fact that the subjects are reacting in an individual manner.

Figure II contains the regression lines for the 15 subjects exercising three days a week for four weeks. Although only nine subjects significantly increased their strength scores, while six remained the same, the lines generally appear to exhibit a sharper rise than those in Figure I. Also, at the con-

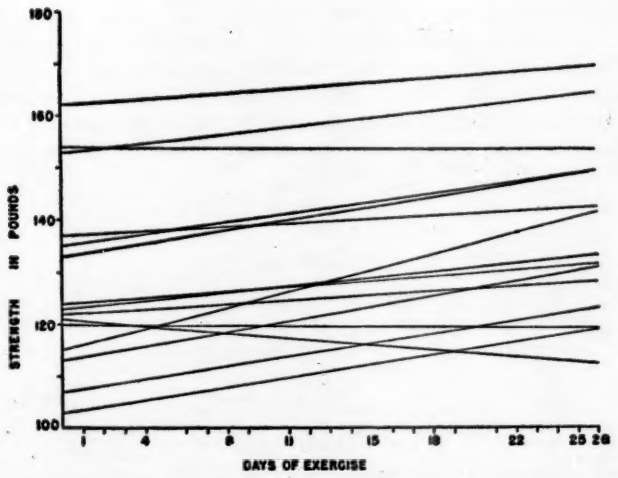

FIGURE I. Regressions of change in strength for 15 subjects exercising twice a week for four weeks: Isotonic contraction.

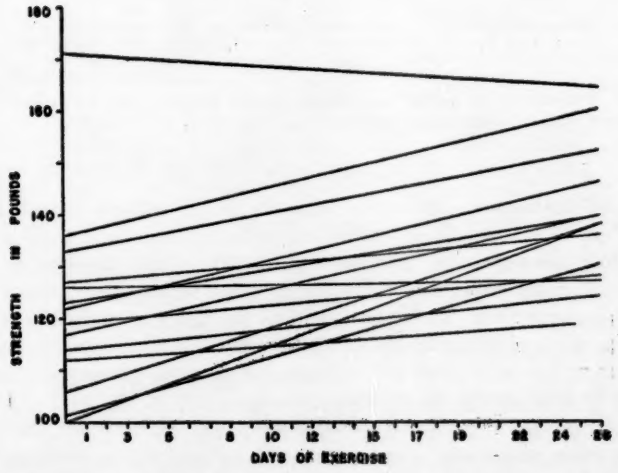

FIGURE II. Regressions of change in strength for 15 subjects exercising three times a week for four weeks: Isotonic contraction.

clusion of the four-week training period, the group as a whole appears to be more homogeneous in terms of strength scores.

Figure III contains 14 regression lines, because two subjects started at 143 pounds and both increased their scores by nine, finishing at 152 pounds. Eleven of the 15 subjects significantly increased their strength scores while four remained about the same. On the whole, the lines appear to show an upward trend, and there seems to be considerable variability in rate of change among the individuals.

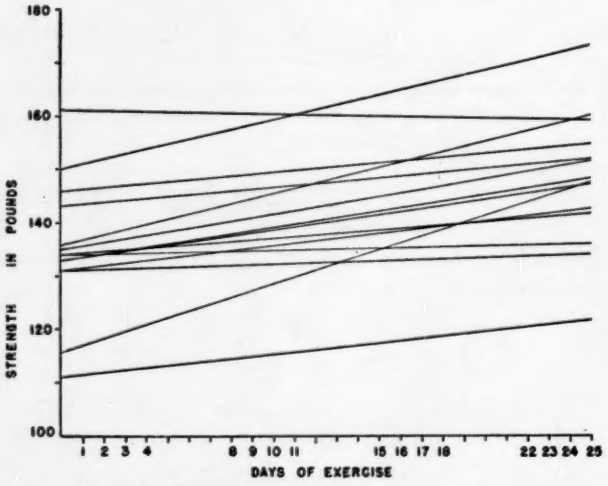

FIGURE III. Regressions of change in strength for 15 subjects exercising four times a week for four weeks: Isotonic contraction.

Figure IV contains the regression lines for the 15 subjects exercising five days a week. Twelve of these subjects significantly increased their strength scores. Only one regression line, starting at 124 pounds, appears as taking a downward trend, while the remaining 14 lines indicate an upward trend. *Isometric Exercise Unit.* The same statistical analysis was applied to the four exercise groups training with the three, six-second static contractions. That is, the four groups were analyzed to determine whether a common regression line existed within any of the groups.

Table 3 contains a summary of the analysis of variance for the groups exercising twice each week. The F ratio with 14° and 90° of freedom equals 2.65 which is significant beyond the .01 level of confidence. From this, we may assume that no common regression exists within this exercise group; and that the strength changes are peculiar to the individual.

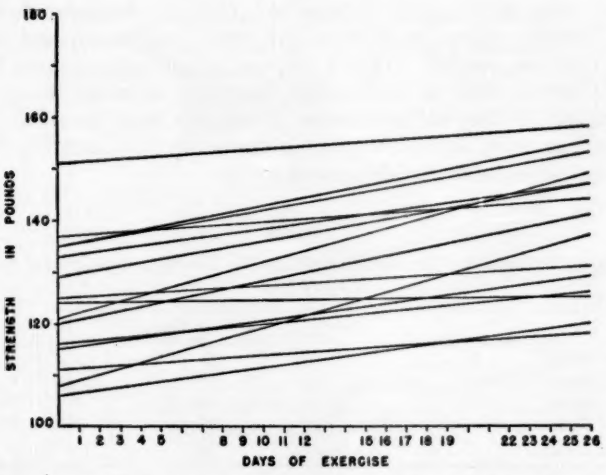

FIGURE IV. Regressions of change in strength for 15 subjects exercising five times a week for four weeks: Isotonic contraction.

TABLE 3

Analysis of Errors of Estimate from Average Regression Within Groups: Two Days Per Week Isometric Contraction

Source of Variation	Degrees of Freedom	Errors of Estimate	
		Sums of Squares	Mean Square
Between Means of Individuals	14	37850	
Average Regression	1	805.8	805.8
Deviation of Individual Reg. from Exercise Group Average Regression	14	382.03	27.25
Deviation from Individual Regression	90	926.17	10.28
		F = 2.65	

This same analysis was computed for the remaining three groups, exercising 3, 4, and 5 days per week for the Isometric Unit. The F tests were significant beyond the .01 level of confidence indicating a common regression line does not exist in any of the groups.

As was stated earlier, the original hypothesis of this study was that individuals would gain strength depending upon the exercise group in which they were placed. However, as a result of these analyses it becomes obvious that rate of strength gain is entirely peculiar to the individual subject. Thus, we cannot test for significance between group regressions for they apparently are non-existent.

Individual Strength Changes in the Isometric Unit. To determine the subjects who significantly gained in strength, the same analysis as used with the Isotonic Unit was applied. Table 4 contains a summary of these findings. This table reveals that, as the exercise frequency increased, there was an accompanying increase in the number of subjects significantly gaining in strength. From eight significant gains in the two-day-a-week group to 15 or 100 per cent gains in the five-day-a-week group.

TABLE 4

Summary of the Individual Strength Changes for the Four Exercise Groups: Isometric Contraction

Exercise Groups	No. of Subjects Gained Strength	No. of Subjects Didn't Gain Strength
2 days per week	8	7
3 days per week	11	4
4 days per week	10	5
5 days per week	15	0
Total	44	16

Figure V contains 15 regression lines for the subjects exercising twice a week by exerting three consecutive, six-second contractions on a strap. Twelve of the lines showed an upward trend; one remained fairly constant; while two indicated a decline. Actually, only eight subjects significantly increased their strength scores, while seven failed to gain.

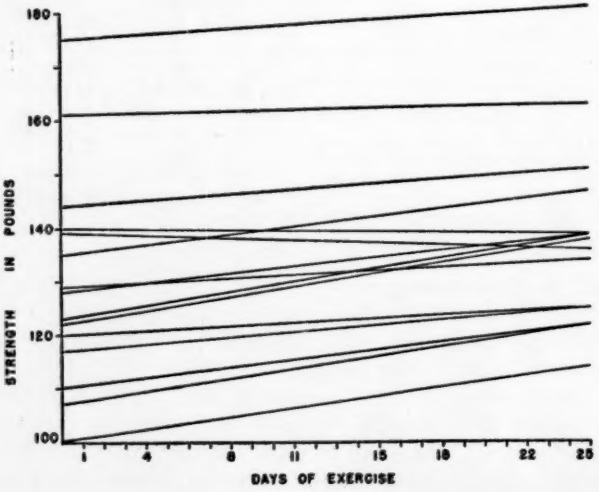

FIGURE V. Regressions of change in strength for 15 subjects exercising twice a week for four weeks: Isometric contraction.

Figure VI shows the regression lines of the subjects exercising three times a week in the Isometric Unit. Eleven of the subjects significantly gained in strength, although 13 of the lines show an upward trend and one a loss. Four subjects failed to make significant gains.

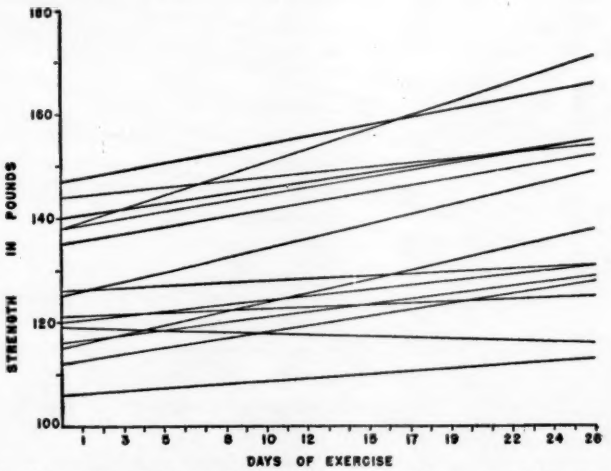

FIGURE VI. Regressions of change in strength for 15 subjects exercising three times a week for four weeks: Isometric contraction.

Figure VII portrays the 15 regression lines for the subjects training four times a week. The 15 lines indicate an upward trend, although only ten subjects significantly increased their strength scores, while five remained at approximately the same level.

Figure VIII contains the Isometric Unit in which the 15 subjects exercised five times a week for the four-week period. All 15 lines show an upward trend and the entire group significantly increased in strength of the elbow flexor muscle group. As compared with Figure III, and particularly Figure IV, these subjects appear to be more homogeneous in terms of strength at the end of the four-week period, than at the beginning of the exercise period.

Conclusions

Within the limitations of this study, the following conclusions, as well as questions, may be suggested.

1. Individuals, regardless of exercise frequency, react in a manner peculiar to themselves. This was borne out by the fact that 1. a common regression line did not occur within either of the two exercise Units; and 2. the individual regression equations, when plotted, exhibit lack of uniformity in terms of rate of increase in strength.

2. As the exercise frequency increased, a greater number of subjects significantly gained in strength in both units.

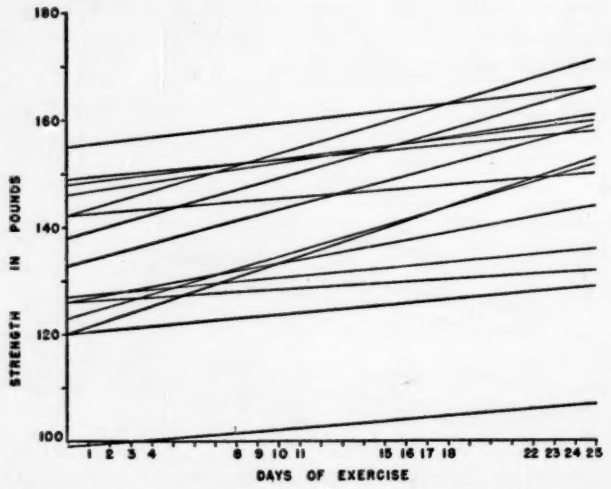

FIGURE VII. Regressions of change in strength for 15 subjects exercising four times a week for four weeks: Isometric contraction.

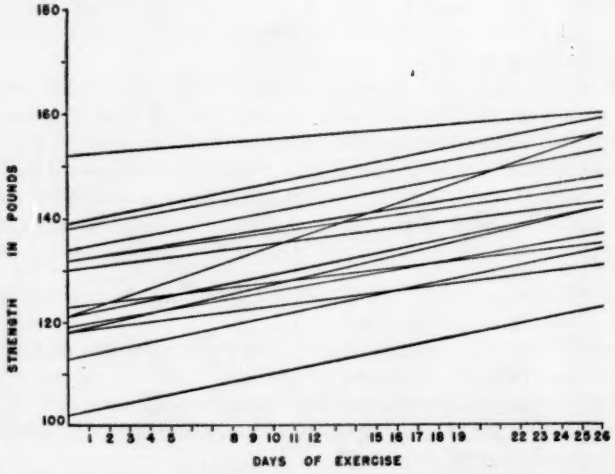

FIGURE VIII. Regressions of change in strength for 15 subjects exercising five times a week for four weeks: Isometric contraction.

3. A total of 41 of the 60 subjects in the Isotonic Unit and 44 of the 60 subjects in the Isometric Unit significantly increased their strength scores. It must be kept in mind that the former group averaged approximately 120 seconds per exercise on the ergometer, while the latter group trained a total of only 18 seconds in executing the three, six-second maximal contractions on the strap. Apparently, the isometric-type contraction results in greater strength gains than does the isotonic-type contraction in terms of the exercises used in this study.

4. One question might be raised relative to the appearance of greater homogeneity among certain groups as they completed the four-week exercise period. Perhaps a common regression might occur among subjects if they were more homogeneous in terms of strength when they started the training. If this is true, it might then be possible to determine if the rate of increase correlates to the number of times per week the subjects exercise.

5. Perhaps greater homogeneity in strength gains might have occurred also if the subjects were selected according to body type as revealed by the findings of Kohlrausch (5) and Herxheimer (2).

6. Obviously, another factor which might account for lack of common regression is the amount of load the subject should carry on the ergometer. The question may be raised, is the three-sixteenths of the individual's elbow flexor strength a sufficient strength proportion for *all* subjects?

7. Should the training period be increased to six or eight weeks to determine whether a common regression will result?

8. Finally, it seems pertinent to suggest that care must be taken in drawing conclusions from similar studies in which the results are interpreted on the basis of mean strength changes. For, in this study, the results would be interpreted somewhat differently as compared to the results found by the analysis of variance of regression lines.

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(Submitted 11/5/56)

Effects of Cold Showers on Circulation of Conditioned and Non-Conditioned Men[1]

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Abstract

One group of nine well-conditioned athletes and one group of nine non-conditioned students, aged 19-25, were tested as to the effects of cold showers on the blood pressure and pulse rate measurements before and following exercise. The exercise consisted of three consecutive one-minute step tests at the rate of 30 steps per minute.

There were differences between the groups in that the conditioned men recovered faster from the exercise regardless of showers.

The cold showers affected the conditioned group more than the non-conditioned with respect to recovery pulse rates and systolic blood pressures. The diastolic blood pressures were not affected by showers.

IN 1943, Steinhaus and Kelso (3) reported their study concerning cold hip baths and the effects on visual functions. Again in 1953, Steinhaus (4) reported on the cold hip bath as it affects the circulation and pointed out that since the study was made on active men, some in physical training programs, that in less active subjects a significant change may occur. With this thought in mind, the present study was undertaken. Its purpose was to compare normal college men with highly conditioned college athletes on a series of step tests and see if cold showers have any effect on the recovery from exercise.

Methodology

Ten members of the Santa Barbara track team, and one member of the wrestling team working out in cross country in preparation for the Olympic team, were used as the conditioned subjects. In the final analysis, two members of the track team were not used owing to their inability to take the complete test.

The final conditioned group of nine men consisted of the wrestler who placed fifth in the Olympic tryouts during the testing phase, and seven track men who were at the peak of training, as evidenced by their marks in running.

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[1]The study was supported in part by a faculty fellowship from the Office of President Sproul, University of California, Berkeley.

[2]The author wishes to express his appreciation to Ernest Carter, track coach, Santa Barbara College, for his help and co-operation.

Nine members of a physiology class were asked to act as subjects, and they represented the non-conditioned group. None of this group was active in any conditioning program.

The conditioned men averaged 21.6 years of age with a range from 19-25 years, 70.4 inches in height with a range from 65-74 inches, and 159.6 pounds body weight with a range from 135-195 pounds.

The non-conditioned men averaged 21.6 years of age with a range of 20-24 years, 71.5 inches in height with a range from 68-76 inches, and 169.2 pounds body weight with a range from 138-197 pounds.

Thus, the average age of the two groups was the same, with the non-conditioned men having an average of 1.4 inches greater height and 9.6 pounds more weight.

TESTS

Some form of standard exercise was needed which would be strenuous enough to tax the well-conditioned and yet could be accomplished by the non-conditioned. Sixty students in a physical education class were used in a preliminary study to determine the kind of test needed for the study. This group consisted of conditioned athletes, women, and normal non-conditioned men.

Step tests and bicycle ergometer rides were taken with the result that one minute stepping up and down on a 17-inch bench gave the most reliable results on test-retest trials, with the 30 steps per minute being the test that all the students could complete. This test caused a significant increase in pulse rate and blood pressure measurements for even the well-conditioned athlete and the measurements returned to normal within 3-7 minutes for the majority of the subjects.

TESTING PROCEDURE

The subjects were tested at 10 A.M. or at 2 P.M., depending on the free hour in their schedule. Each subject was tested twice so that 1-3 days elapsed between the two test days and so that each test series was taken at the same time of the day.

The subject sat in a chair until his pulse rate and blood pressure measurements had leveled off, usually 5-10 minutes. The pulse rate was counted for a 15-second period and the blood pressure was taken during this 15-second time with a desk sphygmomanometer.

The subject then stepped up and down on a 17-inch bench for one minute. After one minute of stepping at a rate of 30 steps per minute, the subject sat down. The pulse rate and blood pressure measurements were taken within 5 seconds for the next 15 seconds and then taken again at 1 minute, 2 minutes, 3 minutes, 4 minutes and 5 minutes after the exercise. The blood pressure measurements usually took around ten seconds to complete, so that the pulse rates and blood pressures were taken simultaneously. After ten minutes of recovery, and when the circulatory measurements had leveled off, the test was repeated a second, and then a third time.

The second day of testing was the same, with the exception of a two-minute cold shower (tap water temperature of 60° F or 15.6° C) being taken prior to the second and third tests.

Statistical Treatment of the Data

Since the subjects were not selected at random, the significance of the data must be judged from the variability of the data found within the sample itself. Each subject was tested on two different days and the standard error of measurement can be estimated from the differences found between Test 1 on the shower day and Test 1 on the non-shower day.

Table 1 gives this variability, with the mean of the differences being shown along with the standard deviation of the differences (σ) and the standard error of the mean of the differences (σa).

TABLE 1

Differences Between Test 1 on Day Without Showers and Test 1 on Day with the Showers

	Before Test	Immediately After	1 Min. After	2 Min. After	3 Min. After	4 Min. After	5 Min. After
			Pulse Rate/Min. Conditioned Men				
M Diff	3.6	5.3	2.7	4.7	4.7	4.4	3.8
σ	4.34	6.0	7.82	6.6	5.6	7.56	4.9
σa	1.45	2.0	2.58	2.2	1.9	2.52	1.6
			Pulse Rate/Min. Non-Conditioned Men				
M Diff	1.3	4.9	−2.2	−.4	4.0	3.1	2.2
σ	6.40	12.3	11.8	7.6	4.0	4.79	5.24
σa	2.15	4.1	3.92	2.53	1.33	1.59	1.75
			Systolic Blood Pressure (mm/Hg) Conditioned Men				
M Diff	1.3	4.5	4.4	3.3	2.0	.9	−.7
σ	4.36	23.45	16.6	8.12	8.18	7.94	11.53
σa	1.45	7.82	5.55	2.71	2.72	2.64	3.84
			Systolic Blood Pressure (mm/Hg) Non-Conditioned Men				
M Diff	.2	−2.2	−.9	−1.5	−.2	−3.1	−.7
σ	5.6	13.2	11.49	25.6	6.35	6.0	7.12
σa	1.87	4.4	3.83	8.5	2.12	2.0	2.37
			Diastolic Blood Pressure (mm/Hg) Conditioned Men				
M Diff	.3	2.4	1.8	1.6	.66	−1.1	−1.1
σ	6.70	9.16	8.24	7.7	5.10	6.8	5.5
σa	2.23	3.05	2.75	2.57	1.70	2.27	1.80
			Diastolic Blood Pressure (mm/Hg) Non-Conditioned Men				
M Diff	−3.1	−2.0	−2.9	−3.1	2.9	−1.2	−3.50
σ	7.96	13.68	8.4	7.9	6.58	3.17	3.32
σa	2.65	4.56	2.80	2.63	2.19	1.06	1.11

The means of the pulse rate differences for the conditioned men ranged from 2.7 to 5.3 beats per minute, while the average difference for non-conditioned men ranged from .4 to 4.9 beats per minute. The standard error of the mean for the conditioned men ranged from 1.45 to 2.58, while for the non-conditioned men the range was from 1.33 to 4.1.

The systolic blood pressure measurements for the conditioned men had an average difference ranging from .2 to 3.1 mm Hg. and a standard error from 1.87 to 8.5.

The mean diastolic pressure differences for the conditioned men ranged from .3 to 2.4 mm Hg., with a standard error ranging from 1.70 to 3.05. With the non-conditioned group, the mean diastolic pressure difference ranged from 1.1 to 3.60 mm Hg. and the standard error from 1.06 to 4.56.

On the test-retest trials, there was little difference between the variabilities of the conditioned and non-conditioned men. The greatest fluctuation usually was seen immediately following the exercise. There was similarly little difference between the blood pressure and pulse rate measurements as to test-retest variance. When the mean of the differences is compared with the standard error, there are no means as high as three times the standard error. This would indicate that no significant changes occurred with day-to-day testing and that only chance fluctuations were present between the first step test results on the day of the shower and on the day when no shower was taken.

Experimental Results

Relationship of the Pulse Rate Measurements. Tables 1 and 2 show the mean changes between tests for the conditioned and non-conditioned men. With the conditioned men, Table 2, there are very little differences between the three repeated tests when no showers are taken. The largest differences are seen in the pulse rates at 3, 4, and 5 minutes following the exercise. When no showers are taken between tests, an element of fatigue is seen in that there is an average increase of 5 per cent in the pulse rate from Test 1 to Test 3 (see Table 3).

TABLE 2

Mean Pulse Rates/Minute for Conditioned Men

	Before Test	Immediately After	1 Min. After	2 Min. After	3 Min. After	4 Min. After	5 Min. After
With Rest Between Tests							
Test 1	62.7	105.8	64.4	60.4	60.7	60.7	62.0
Test 2	62.2	104.9	63.3	63.8	63.6	63.1	63.1
Test 3	63.3	105.1	66.0	63.8	65.8	65.8	65.3
With Shower Between Tests							
Test 1	66.2	111.1	67.1	65.1	65.3	65.1	65.8
Test 2	59.8	102.2	63.1	60.7	62.9	63.1	64.4
Test 3	58.4	98.9	58.7	58.0	58.7	58.2	59.3

TABLE 3

Pulse Rate/Minute Differences Between Tests 1 and 3 for Conditioned Men

	Before Test	After Test	1 Min. After	2 Min. After	3 Min. After	4 Min. After	5 Min. After
			Showers Between Tests				
M Diff	−7.8	−12.2	−8.4	−7.1	−6.7	−6.9	−6.4
σ	3.87	8.30	7.28	4.71	3.62	4.82	4.34
σa	1.29	2.76	2.42	1.57	1.21	1.61	1.48
σ meas*	1.45	2.0	2.58	2.20	1.90	2.52	1.60
			Without Showers Between Tests				
M Diff	.6	−.7	1.6	3.4	5.1	5.1	3.3
σ	4.9	8.39	4.25	4.50	4.60	4.50	4.50
σa	1.63	2.79	1.42	1.50	1.53	1.50	1.50
σ meas	1.45	2.0	2.58	2.20	1.90	2.52	1.60

*Standard error of the mean of the differences found from table 1 by dividing the standard deviation of the differences on test retest trials by the $\sqrt{N}$

When the shower is taken between tests by the conditioned men, there is a drop in pulse rates even during the rest period before the test begins. (As shown by Table 3, these differences are all significant if we consider that the differences exceed three times the standard error of the mean as well as the standard error of measurement (Table 1), with an average drop of 10 per cent being found at each of the minutes during the testing.

Table 4 shows the results of the non-conditioned men. With this group there is likewise an increase between Tests 1 and 3 when no shower is taken. With this group the increase owing to fatigue is greater than with the conditioned men, being about 8 per cent on the average (see Table 5).

TABLE 4

Mean Pulse Rates/Minute for Non-Conditioned Men

	Before Test	Immediately After	1 Min. After	2 Min. After	3 Min. After	4 Min. After	5 Min. After
			With Rest Between Tests				
Test 1	74.2	124.4	88.9	80.4	76.4	76.9	76.2
Test 2	76.0	127.6	92.0	83.6	83.1	80.9	79.1
Test 3	78.2	125.3	94.7	87.3	82.7	81.8	80.1
			With Shower Between Tests				
Test 1	75.6	129.3	86.7	80.0	80.4	80.0	78.4
Test 2	74.0	128.4	84.0	78.7	77.3	76.9	75.6
Test 3	78.2	123.1	82.2	78.2	77.3	76.9	76.4

None of these increases reaches a level of significance (i.e., three times the σa or σ meas.), so that also with this group the changes fall within chance fluctuations when showers are not taken.

TABLE 5

Pulse Rate/Minute Differences Between Tests 1 and 3 for Non-Conditioned Men

	Before Tests	Immediately After	1 Min. After	2 Min. After	3 Min. After	4 Min. After	5 Min. After
			Showers Between Tests				
M Diff	2.6	−6.2	−4.5	−1.8	−3.1	−3.1	−2.0
σ	9.03	15.4	8.90	6.69	3.88	5.31	7.22
σa	3.01	5.13	2.97	2.23	1.29	1.77	2.41
σ meas	2.15	4.1	3.92	2.53	1.33	1.59	1.75
			Without Showers Between Tests				
M Diff	4.0	.9	5.8	6.9	6.3	4.9	4.5
σ	4.0	15.0	6.68	12.28	6.98	7.17	4.68
σa	1.33	5.0	2.23	4.13	2.33	2.39	1.56
σ meas	2.15	4.1	3.12	2.53	1.33	1.59	1.75

When showers were taken by the non-conditioned men, there was a similar drop as found in the conditioned men but because of erratic differences between the non-conditioned men's reaction, statistical significance at three times the σa or σ meas. was not reached at any point during the tests. The average drop between tests was consistent at each of the minutes, being about 4 per cent, but much lower than the 10 per cent found with the conditioned men.

Throughout the experiment, the non-conditioned subjects averaged 15-20 per cent higher pulse rates, and from Tables 1 and 2 it can be seen that at all times the conditioned men's pulse rates returned to normal in 1-2 minutes while the pulse of the non-conditioned men took over 5 minutes to return to normal.

The showers made no significant changes within either group on the time of the pulse rates to recover.

Two of the track men consistently showed a phenomenon of the pulse rate dropping below normal at one minute following exercise, then slowly climbing back by the end of 4 minutes.

Relationship of the Systolic Blood Pressure Measurements. Tables 6 and 7 show the systolic blood pressure changes during the testing. When no showers were taken, the conditioned men (see Table 6) usually had a slight blood pressure increase between Tests 1 and 3 but not significantly, as shown in Table 7.

When showers were taken, there was a consistent decrease between Tests 1 and 3 except before the testing, as with the non-shower day. As a result of the showers, the conditioned men showed a decrease between Tests 1 and 3 at each of the minutes following the exercise. Table 1 shows that the significance was not reached, though there was an average decrease of 5 per cent between Tests 1 and 3.

TABLE 6

Mean Systolic Blood Pressure (mm/Hg) Conditioned Men

	Before Tests	Immediately After	1 Min. After	2 Min. After	3 Min. After	4 Min. After	5 Min. After
With Rest Between Tests							
Test 1	121.1	167.8	145.6	132.7	127.1	126.4	125.1
Test 2	124.2	166.0	146.7	134.0	130.4	124.0	125.1
Test 3	124.9	166.2	146.9	135.8	131.8	124.4	125.6
With Showers Between Tests							
Test 1	119.8	163.3	141.1	136.0	129.1	127.3	124.4
Test 2	124.2	161.3	140.7	129.3	125.6	122.9	121.3
Test 3	124.2	155.6	136.7	128.2	125.6	122.9	120.7

TABLE 7

Systolic Blood Pressure Differences (mm/Hg) Between Tests 1 and 3 for Conditioned Men

	Before Test	Immediately After	1 Min. After	2 Min. After	3 Min. After	4 Min. After	5 Min. After
Showers Between Tests							
M Diff	4.4	−7.8	−4.4	−7.8	3.5	−4.4	
σ	5.65	9.10	9.22	8.82	6.80	5.96	
σa	1.88	3.10	3.08	2.93	2.27	1.99	
σ meas	1.45	7.82	5.55	2.71	2.72	2.64	3.84
Without Showers Between Tests							
M Diff	3.8	−1.6	1.3	3.1	4.7	−2.0	.5
σ	3.32	6.34	8.32	3.10	6.94	6.18	5.85
σa	1.10	2.11	2.77	1.03	2.31	2.06	1.95
σ meas	1.45	7.82	5.55	2.71	2.72	2.64	3.84

The non-conditioned men showed a decrease between 1 and 3 regardless of whether showers were taken or not. Table 8 shows that at 3 and 4 minutes significance was reached when showers were taken ($3 \times \sigma a$ and σ meas.). This decrease in blood pressure between Tests 1 and 3 reflects the return of the measurements to normal within 4 minutes during Test 3, while on Test 1 the return was not accomplished until 7 minutes had elapsed (see Table 8). This occurred both with and without showers. The exercise itself seemed to cause a vasodilation which was not affected by the shower. As the blood flow decreased, the blood pressure dropped.

There was very little difference between the conditioned and non-conditioned men with respect to the blood pressure. The only consistent difference occurred at the first and second minutes after exercise, when the non-conditioned men had an average of 5% higher than the conditioned men.

TABLE 8

Mean Systolic Blood Pressures (mm/Hg) for Non-Conditioned Men

	Before Test	Immediately After	1 Min. After	2 Min. After	3 Min. After	4 Min. After	5 Min. After
With Rest Between Tests							
Test 1	124.2	165.3	155.6	145.3	138.0	133.8	129.1
Test 2	127.3	164.0	154.7	144.0	135.8	130.6	128.7
Test 3	126.7	163.1	152.4	141.3	130.9	127.6	125.3
With Showers Between Tests							
Test 1	124.4	163.1	154.7	143.8	137.8	130.7	128.4
Test 2	126.9	154.1	148.7	138.9	132.9	128.2	126.0
Test 3	126.0	156.2	148.2	136.4	130.0	126.0	124.0

TABLE 9

Systolic Blood Pressure (mm/Hg) Between Tests 1 and 3 for Non-Conditioned Men

	Before Test	Immediately After	1 Min. After	2 Min. After	3 Min. After	4 Min. After	5 Min. After
Showers Between Tests							
M diff	1.6	−6.9	−6.5	−7.4	−7.8	−4.7	−4.4
σ	6.55	11.9	5.83	9.84	6.58	4.71	4.90
σa	2.18	3.97	1.63	3.28	2.19	1.57	1.63
σ meas	1.87	4.40	3.83	8.50	2.12	2.0	2.37
Without Showers Between Tests							
M diff	2.5	−2.2	−3.2	4.0	−7.1	−6.2	−3.8
σ	4.0	7.92	7.64	8.50	6.81	6.30	6.14
σa	1.33	2.64	1.63	2.83	2.26	2.1	2.05
σ meas	1.87	4.40	3.83	8.50	2.12	2.0	2.37

Relationship of the Diastolic Blood Pressure Measurements. Tables 10, 11, 12, and 13 show the changes of the diastolic blood pressure measurements. There were no consistent differences between the two groups due to the cold showers. With the conditioned men, the pressure increased from Tests 1 to 3. The diastolic blood pressure measurements always dropped after exercise and returned to normal within 4-5 minutes on Test 1 while returning in two minutes on Test 3. With the non-conditioned men, the diastolic pressure fluctuated more so that between Tests 1 and 3 it dropped for some as well as increased for others and took 4 to 5 minutes to return to normal. The fourth phase diastolic pressure was used in this study. Since the systolic pressure took 5-10 seconds to find, the diastolic pressure following exercise thus represented the pressure as found about 15 seconds after the exercise ended and immediately following the 15-second count of the pulse rate.

TABLE 10

Mean Diastolic Blood Pressures (mm/Hg) for Conditioned Men

	Before Test	Immediately After	1 Min. After	2 Min. After	3 Min. After	4 Min. After	5 Min. After
With Rest Between Tests							
Test 1	79.6	65.6	76.7	76.0	77.6	78.7	80.0
Test 2	80.7	68.7	76.7	77.6	79.6	81.3	81.8
Test 3	79.6	69.8	78.0	80.2	81.6	80.4	81.3
With Showers Between Tests							
Test 1	79.3	63.3	74.4	77.6	78.2	77.6	78.9
Test 2	78.9	68.9	76.4	80.7	79.8	79.8	79.1
Test 3	79.3	69.3	76.2	78.4	79.1	80.9	81.1

NOTE: The diastolic blood pressures were recorded as the fourth phase diastolic pressures.

TABLE 11

Diastolic Blood Pressure Differences (mm/Hg) Between Tests 1 and 3 for Conditioned Men

	Before Tests	Immediately After	1 Min. After	2 Min. After	3 Min. After	4 Min. After	5 Min. After
Showers Between Tests							
M diff	0	6.0	1.8	.8	.9	1.3	2.2
σ	4.0	7.56	6.84	8.32	6.25	6.02	4.54
σa	1.33	2.52	2.28	2.77	2.06	2.01	1.51
σ meas	2.23	3.05	2.75	2.57	1.70	2.27	1.80
Without Showers Between Tests							
M diff	0	4.2	1.3	4.2	4.0	1.7	1.3
σ	2.0	6.80	9.63	7.70	5.10	2.75	3.1
σa	.66	2.26	3.21	2.57	1.70	.91	1.03
σ meas	2.23	3.05	2.75	2.57	1.70	2.27	1.80

TABLE 12

Mean Diastolic Blood Pressures (mm/Hg) for Non-Conditioned Men

	Before Test	Immediately After	1 Min. After	2 Min. After	3 Min. After	4 Min. After	5 Min. After
With Rest Between Tests							
Test 1	80.2	68.9	73.8	76.7	78.0	77.6	80.4
Test 2	80.7	67.3	77.8	78.4	78.7	78.9	79.1
Test 3	79.6	67.8	76.0	76.2	76.2	77.1	78.9
With Showers Between Tests							
Test 1	77.1	66.9	76.7	73.6	75.1	76.4	76.9
Test 2	81.3	64.0	75.2	76.4	78.7	79.3	78.2
Test 3	78.9	66.1	74.9	76.7	75.6	78.2	77.8

NOTE: The diastolic blood pressures were recorded as the fourth phase diastolic pressures.

TABLE 13

Diastolic Blood Pressure Differences (mm/Hg) Between Tests 1 and 3 for Non-Conditioned Men

	Before Tests	Immediately After	1 Min. After	2 Min. After	3 Min. After	4 Min. After	5 Min. After
Showers Between Tests							
M diff	1.8	−.8	−1.4	3.1	.5	1.8	.9
σ	6.37	5.84	7.65	5.22	8.70	5.96	2.48
σa	2.12	1.95	2.55	1.74	2.90	1.99	.83
σ meas	2.65	4.56	2.80	2.63	2.19	1.06	1.11
Without Showers Between Tests							
M diff	−.6	−1.1	2.2	−.5	−1.8	−.5	−1.5
σ	5.49	9.82	5.35	5.19	5.82	5.46	4.78
σa	1.83	3.27	1.78	1.73	1.94	1.82	1.59
σ meas	2.65	4.56	2.80	2.63	2.19	1.06	1.11

The pulse rate had dropped considerably by the time the first diastolic pressure was taken and the loud sound of the after exercise pulse rate made it difficult to find the fourth phase. It is possible that this point was masked by the pulse beat, and this would account for a lowered diastolic pressure after exercise. Since the pressure was usually below normal for three minutes, it can be assumed, however, that the drop was a reality. Both conditioned and non-conditioned men demonstrated this same phenomenon with only three of the conditioned and two of the non-conditioned ever having an increase in pressure immediately following the exercise.

Discussion

The significant changes of the pulse rates as the result of the showers confirm the studies of Happ (1), and Steinhaus (5). In the present study the pulse rates of the conditioned men were affected more than the non-conditioned. This is contrary to what was expected, since it was suggested by Steinhaus (5) that perhaps a greater effect could be obtained on poorly conditioned subjects. This author also felt the same would happen; hence, the data were further examined to see if there was any difference between the groups on the day of the shower and on the non-shower day. It is interesting to note that with the conditioned men there was a consistently higher pulse rate on the shower day, compared with non-shower days before the first test (see Table 2). The average difference was 3.5 beats/min. After the shower there was always a drop from Test 1, so that this apprehension was overcome. Since no other consistent changes were found between Test 1 on non-shower days and shower days, it was felt that the changes found were not influenced by this emotional factor. Why the non-conditioned men were not affected by the psychology of the showers is difficult to explain. It may be that the conditioning causes an emotional readiness to stress not found in the normal man who has a resting pulse rate too high to be affected.

Along this same line of thought, it is significant that the cold showers affected the conditioned men throughout the testing to lower the pulse rates significantly while the poorly conditioned men were only slightly affected.

The reaction of the conditioned men to the exercise, as far as pulse rates are concerned, followed the accepted belief in showing faster recovery as a result of exercise than non-conditioned men show. The reaction to cold showers, however, is different. The conditioned group are more influenced by showers, with the two distance runners who were considered to be in the best condition (by their records this year) affected the most. This is a point that should be investigated more thoroughly.

The present study does not confirm the effects of showers on the systolic blood pressures following exercise that Steinhaus (5) found on standing pressures, since both of the groups showed a reduction in systolic blood pressures following exercise when showers were taken. It was not significant with the non-conditioned group, since there also was a drop between Tests 1 and 3 without the shower.

With the conditioned group, the diastolic blood pressures increased between Tests 1 and 3 with and without showers; they decreased with the non-conditioned group. This is different from the report by Happ (1), who showed an increase following cold packs. Since the changes were only slight with either group, no importance can be attached to this phenomena.

The use of over-all body showers in this study and the time of two minutes for submersion may have caused less change than possible. It may be that the conditioned men react faster to cold and need less stimulus, while the non-conditioned men may require a much longer time to become affected by cold showers.

Better and more consistent results may have been produced if five or six series of tests were taken. There was a comment made by the non-conditioned men to the effect that their legs were tired after three tests were given. If this muscular fatigue is not affected by showers, then this factor could have been reflected in the circulatory adjustment, giving the conditioned men an advantage in the study.

Throughout the testing, differences between shower and non-shower days, and between conditioned and non-conditioned men, were not noted in the actual changes made during the exercise; i.e., between the measurements before and immediately after stepping. The pulse rates always increased around 40-50 beats/minute while the systolic blood pressure increased around 40 mm/Hg and the diastolic pressure dropped about 15 mm/Hg. Differences occurring in this study were found in the return of the measurements to normal and in the lowered measurements at different points in the testing.

Summary

Three series of step tests were given on two different days to 18 male students between the ages of 19 and 25. Between the step tests, the students

either rested or took cold showers (60°F). The test consisted of a one-minute step on a 17-inch bench, with pulse rate and blood pressure measurements being taken before, immediately after, and at each minute for the next five minutes. The shower was taken for two minutes and a total of ten minutes elapsed between the tests.

A comparison was made between the results of the step tests when showers were taken and when no showers were taken. The 18 male students consisted of a well-conditioned group of nine and a non-active group of nine.

The results showed the following:

1. The conditioned group was affected more by the showers than the non-conditioned group.
2. Both groups had increased pulse rates after three step tests and a decrease after showers were taken. However, the conditioned group decreased significantly while the non-conditioned group failed to reach significance based on the σa or σ meas.
3. The non-conditioned group was influenced by the showers with respect to the systolic blood pressure which returned to normal sooner following the exercise.
4. Between Tests 1 and 3, the cold showers caused the conditioned group to have consistently lower systolic pressures, while the non-conditioned group had lower pressures between Tests 1 and 3 both with and without showers. Significance was not reached with either group, however.
5. The diastolic blood pressures were not affected by the cold showers in either group.
6. The conditioned men always had pulse rates that were lower than the non-conditioned men, and their pulse rates returned to normal faster regardless of cold showers.
7. The showers did not affect either group in the increase of the measurements from resting to exercise, nor was there any difference between the two groups as to measurement changes owing to exercise. The systolic blood pressure and the pulse rates always increased during exercise, while the diastolic blood pressure always decreased.

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Stress Adaptation Through Exercise

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Abstract

This article presents research studies concerning the effects of exercise upon the adrenal glands and the autonomic nervous system. The evidence supports the theory that repeated exercise "conditions" the stress adaptation mechanism. The ability to adjust to stress is helped through an increased sensitivity of the adrenal glands and less adjustment necessary because of a more efficient mechanism resulting from an exercise program.

REGULAR EXERCISE programs have been found to improve muscular strength, motor skills, and circulation (4,5,8,9,13,14). Increases in strength and motor skills improve the efficiency of movement and help prevent fatigue caused by physical exertion. The increase in muscular tone also aids the venous return of the blood which in turn augments the circulation. The improvement in circulation is reflected in the slowing down of the pulse rate during training, in the faster return to normal of the pulse rate after exercise and in the improved blood pressure responses following a training program.

Along with the general improvement in fitness, a sense of well-being or a feeling of good health usually results from exercise. The feeling is subjective and the report is not accepted by many as reliable data. This euphoria may well be emotional in nature and, therefore, result in part from an adjustment of the autonomic nervous system. If this is true, then exercise may prove to be important in man's adjustment to stress.

Review of the Literature

Selye (20) in his report of stress advanced the theory that man is faced with two types of stress, specific and non-specific. If a non-specific stress is encountered repeatedly there is an alarm reaction following this pattern:

1. Shock—depression of the nervous system
2. Counter shock—enlarged adrenal cortex, increased activity of the nervous system
3. Exhaustion—develops when further resistance cannot be maintained.

If the alarm reaction is repeated, either general adaptation or breakdown takes place. The general adaptation syndrome of Selye concerns the adrenal cortex and a "learning" process of defense against future exposures of the same stress.

Since Selye, other studies have provided evidence concerning similar adjustments of the body to the external changes in the environment. Engel (6) reports the use of increased steroids as evidence of adrenal secretion during

stress. It was suggested that the presence of excess adrenal hormone sensitizes the organism to respond metabolically to stimuli of lower impact while absence of the anterior pituitary or adrenal cortex causes inadequate response to stress.

Further evidence of the relationship between emotional states and the endocrine system was provided by Kramer (12) who reported the increase and then the decrease of capillary resistance as a result of stress. He attributes the rise of resistance to increased pituitary—adrencortical activity while the decrease, or capillary crisis, results from the adrenal cortex.

There is general agreement that the adrenal glands are very important with respect to stress (19). Opinion differs, however, concerning the sympathetic and parasympathetic systems in regard to specific stresses. Arnold (1) and Ax (2) discuss the different viewpoints with respect to anger and fear. Arnold feels that fear is sympathetic and anger is both sympathetic and parasympathetic and that anger, though both sympathetic and parasympathetic is more parasympathetic. Both agree with the presence of a dominant sympathetic (epinephrine) reaction to fear and a combination reaction to anger. Arnold (1) suggests that fear corresponds to the stress of cold (balance restored during parasympathetic overactivity) and anger corresponds to the stress of heat (balance restored during sympathetic overactivity).

Regardless of which theory is preferred, it is agreed that stress affects the autonomic nervous system with the sympathetic and parasympathetic reactions adjusting until balance is restored. If there were some means of improving the autonomic system, more efficient reactions to stress would result. The shock phase should be minimal, and the counter shock mechanism should adjust rapidly. The result would reduce the chance for exhaustion because of minimum counter-balance activity.

Physical Activity and the Autonomic Nervous System

The effects of physical activity on the adrenal and the autonomic nervous system have been shown indirectly in recent studies by Richter (17) and Hoagland (10).

Richter (17) reported that the wild rat had large adrenals compared with the domestic rat and that surgical trauma along with ACTH has little influence upon the ascorbic acid content, indicating maximum stimulation. When the adrenals were removed, the wild rat died more easily than the domestic, as if the active animal was more dependent on the adrenals. Hoagland (10) used the 17 ketosteroids as a measure of adrenal response and pointed out that the higher skilled and less fatigued men have less adrenal activity. The production of the 17 ketosteroids declined with age and also with fatigue during the afternoon. It seems that the more active and less fatigued men have better adrenal function.

Van Liere (23) in 1954 was one of the first to report a direct relationship between physical training and the autonomic nervous system. He found that

exercised rats had increased propulsive motility of the small intestine compared to non-exercised rats. The possible explanation was a dominance of the parasympathetic system. This dominance of the parasympathetic system is also reflected in the lower pulse rates of the trained men (4,5,8,14).

Bartlett's study also showed a direct relationship between physical training and emotional stress. He pointed out that daily exercise produces a degree of inhibition to restraint hypothermia. Adaptation to exercise stress appears to protect against the emotional stress produced by restraint, and manifested through the body temperature drop when exposed to cold. Michael (13) also reported the response to cold to be more pronounced with highly trained athletes than with normal young men. Apparently, an exercise program causes an increased adrenal sensitivity, for, as Engel (6) points out, the presence of excessive adrenal hormones seems to sensitize the organism to respond to lower stimuli. In studies on athletes, Michael (13) and Johnson (11) reported heightened emotional responses of these men before athletic functions. The more "keyed" the group, the better playing ability.

Since repeated physical activity seems to sensitize and increase the size of the adrenal glands, it is possible that this results in a more efficient reaction to stress. The increased sensitivity would result in a shortened time-lapse between shock and counter shock, while the increased size of the adrenals suggests a greater reserve of the counter shock steriods. Thus, following a stress a "conditioned" person might expect an improved adjustment to the shock.

Exercise and Adaptation to Stress

If Selye's theories of stress are tenable, then the stress of repeated exercise should cause either a breakdown or adaptation. Exercise, by affecting the adrenal glands, affects the mechanism by which the body combats stress and therefore should be considered as a possible means of helping to strengthen the adaptation process. Williams (25) and Steinberg (21) both showed that emotionally unstable groups have heightened levels of physiological activity and, as Steinberg reported, inferior physical fitness. Taylor (22) pointed out that forced bed rest has been found to reduce the body to a dangerous state similar to starvation. It is possible then that exercise provides a means of strengthening the adaptive mechanism of the body. Exercise might well be a means of increasing the survival potential in a tense, emotional age.

Persky (16), in discussing stress, points out the difference between physical activity and psychological (emotional) stress. He reports that blood eosinophil and glutathione levels are affected only by psychological stress. Thus, exercise can affect the adaptive mechanism without itself increasing the reaction caused by emotions. The advantage of exercise lies in the fact that it stimulates the defense mechanism, not that it is similar to other stresses.

The implications of using exercise as a means of adapting to stress raises many questions that cannot be answered at this time. How much exercise and

what are the best kinds of exercise might be asked. An investigation of these questions should result in a series of interesting studies.

Conclusions

The evidence reported here supports the theory that repeated exercise "conditions" the stress adaptation mechanism. The studies point out that the adrenocortical activity along with the autonomic nervous system are involved in adjusting to stress. This ability to adjust is helped with exercise if we assume that the more sensitive response to stress reduces the time necessary to elicit a response and therefore lessens the duration of the adjusting phase. The evidence indicates that adaptation to exercise produces a degree of protection against emotional stress. The increased adrenal activity resulting from repeated exercise seems to cause an increased reserve of steriods available to counter a stress. A lack of activity was reported to reduce the ability to withstand stress, as if the reaction to a shock is a "learned" process.

The questions raised by this theory are numerous and challenging. If we accept the theory, the possibility exists that exercise, being a stress, might aid adaptation and at the same time bring about a breakdown. As Selye points out, the dangers of a therapeutic agent might be in the resulting syndrome of adaptation.

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Improvement in Jumping Performance Due to Preliminary Exercise[1]

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Abstract

Ten experienced subjects each made 90 or more vertical jumps preceded by isometric stretching exercises, isotonic work (running in place), or a combination (knee bends). Compared with control conditions (no preliminary exercise), performance was improved for each individual and by each of the three exercises. The average gains showed high statistical significance. In a second experiment, 50 young men each made 10 jumps. Psychological control was secured by disguising the purpose of the tests. Warm-up exercises again improved performance to a significant extent. The observed gains averaged 2.9 to 7.8 percent. The Henry jump-testing apparatus gave reproducible results when compared with earlier studies and revealed reliable individual differences in jumping ability ($r = .975$).

IT IS CONTROVERSIAL, on the basis of the data available at the present time, as to whether the use of preliminary exercise is beneficial in athletic activity. However, most physical educators and coaches have taken for granted that the facts are firmly established, and such "warm-up" exercises are widely used in the expectation that athletic injuries will be reduced and performance will be improved.

The present investigation will be limited to the latter problem, namely the possibility of improved physical performance as a result of preliminary or pre-performance muscular exercise.

Review of Recent Literature

Preliminary exercise failed to improve the 50-yd. sprinting performance in a group of 28 junior high school boys tested by Hipple (6). With pre-race warm-up kept at a minimum, the first of a series of five sprints was considered as preliminary exercise for the second, and the first and second were considered preliminary for the third. The results showed no significant difference between the mean speeds of the first, second, and third races. The fourth and fifth were run more slowly, indicating that the amount of exercise was sufficient to produce fatigue. Carlisle (2) has explained Hipple's negative results on the basis that the age group with which Hipple was dealing might fatigue earlier than more mature trained subjects. He also questions the advisability of an all-out run as a method of preliminary exercise.

The previous findings at Springfield College support Hipple's results. Karpovich (7, p. 14) has reported that warm-up exercise did not improve performance in swimming 100 yd. Hale (3), using a 440-yd. run, found that

[1]From the Research Laboratories of the Department of Physical Education. The writer is indebted to Professor Franklin Henry for advice and encouragement.

preliminary exercise had no significant effect in improving performance. Using seven college-age track men as subjects, he gave specific calisthenics and short wind sprints for a period of ten minutes as preliminary exercise. The subjects ran 440 yd. Hale was aware of the importance of psychological control, and employed "digital stroking" as a placebo. This involved light stroking of the muscle groups which were to be used in the run. No significant difference was found between the mean time for performance with or without preliminary work. In fact, Hale noted that one of the best Springfield College indoor track records was made without any type of preliminary exercise. His study was also concerned with the effect of preliminary massage. He found that massage improved the run 1.17 per cent. The "t" ratio for this improvement, computed from his data, is 4.24.

With the purpose of determining the mechanism of improvement from preliminary exercise, Asmussen and Boje (1), in 1945, studied the role of increased body and muscle temperature as causal agents. Four methods were used to raise the temperature: radio diathermy, massage, hot showers, and preliminary work. Four subjects were used in the study. In contrast to the findings reviewed above, Asmussen and Boje have found that preliminary work exerts a decidedly favorable effect upon performance. Improvement ranged from 2 to 7 per cent. However, the amount of warm-up exercise used was rather large, up to 660 kgM/min. for 30 min. Only an experienced athlete in excellent training status could be expected to accomplish so much preliminary work without fatigue.

Asmussen and Boje also found that heating by diathermy increased performance 3.9 to 7.6 per cent, while hot showers resulted in an improvement of 5.0 to 7.2 per cent. Massage, in contrast to Hale's experiment, caused no significant improvement in performance. After investigating the muscle temperatures and blood temperatures during these various methods of heating the body, these investigators concluded that the improvement in performance could be attributed to the rise in muscle temperature.

Muido (8) was also concerned with the influence of preliminary exercise and body temperature rise upon performance. His factual results are in agreement with those of Asmussen and Boje. The three subjects improved their swimming performance 0.6 to 2.2 per cent as a result of ten minutes of preliminary "jogging." With heavy preliminary work on the bicycle ergometer for a ten-minute period at a rate of 1,080 kgM/min., Muida found that the scores of the swimmers improved 1.4 to 2.6 per cent. He also raised the body temperature of the subjects by giving them hot showers of 15 to 18 min. at a temperature of 40° to 43° C. The results showed 2.1 to 3.9 per cent improvement in swimming time. Heating by diathermy improved performance 1.3 to 1.9 per cent. Cold baths, however, had a detrimental effect (—3.6 to —6.3%). Muido has disagreed with Asmussen and Boje over the physiological basis for the improved performance. He attributes it to increased blood temperature rather than local muscle temperature increase. Carlisle did

not measure muscle temperature; nevertheless, he believes that his improvement of 1 per cent due to hot showers is to be attributed to changed muscle temperature rather than increased blood temperature.

One can see from the above review that previous studies (except Hipple's) have been concerned with observations of only small numbers of subjects, and these have been trained athletes. Frequently, the preliminary exercise has been the same activity as that used in the test performance. No attention seems to have been given to the possible value of isometric exercises (which produce very little body heat), although these are frequently used in the preparation of athletes for competitive performance. Hale, Hipple, and Karpovich have been unable to show that warm-up exercises have a beneficial effect, although the previous studies of Asmussen and Boje, and of Muido, reported evidence of improved performance after preliminary work. These unresolved questions constitute the basis of the study reported below.

Experiment 1

Method. Henry's vertical jump apparatus[2] and technique (4) were used to test ten graduate students (9 males and 1 female). Six jumps, each separated by 1.5 min. rest, were made during each test period, and on one day. Three of the subjects had two practice periods before testing was started. The others had been given varying amounts of additional practice. Using a rotating order of presentation of periods to balance out practice or training effects, each subject was given five to ten test periods under each of four preliminary exercise conditions:

A. *Control.* No preliminary exercise was permitted.

B. *Stretching of Leg and Hip Muscles.* The subject assumed a deep lunge position with the front foot about 22 in. ahead of the other, slowly shifting weight to the forward foot while contracting the muscles for 15 sec., then shifting the weight backwards for 15 sec. The position of the feet was then reversed. The process was repeated until 3 min. of stretching was completed. This length of time was not entirely arbitrary; it seemed to be about the maximum amount the subjects could do without being troubled with fatigue or tightening of the muscles. This preliminary exercise was almost entirely isometric; it resulted in a mean heart rate increase of 14.2 beats/min.

C. *Stationary Running.* The subjects were instructed to run 3 min. flat footed, minimizing muscle stretching insofar as possible, and to select an individual pace that could

[2]Professor Henry has improved the original apparatus. Skeleton construction has been used for both the driving and indicator sliders in order to decrease mass. The driver now weighs 1.6 grams and the indicator 2.1 grams. A piece of thin leather 3 by 8 mm. has been cemented to the end of the friction spring of the indicator, in order to provide more consistent friction. Sliding friction has been set at 20 to 22 grams. The length of the 0.8 cm. rod that carries the sliders has been increased to 2.15 meters to allow more freedom of movement, and the meter scale has been moved closer to the rod so that the pointer is not required. It has been found necessary to remove the brake mechanism from the casting reel that provides 130 grams cord tension, because this sometimes caused drag. The rod has been carefully polished with crocus cloth. To prevent the cord from jumping off, the upper pulley is now provided with a close-fitting cover over the upper half, and the thickness of the part of the cord that travels over this pulley has been increased to 1.7 mm.

be comfortably maintained but which would result in a good workout. It is realized that considerable stretching may have occurred. The heart rate increase averaged 43.6 beats/min.

D. Deep Knee Bends. This exercise consisted of six deep knee bends per 30 sec. Toe flexion was emphasized. There were four such periods, each separated by 15 sec. of rest, giving a total time of 3 min. For the average subject this meant working at 366 kgM/min. for a total of 1100 kgM of isotonic work. It resulted in a mean heart rate increase of 22.8 beats/min.

FIGURE I. Apparatus for Measuring Jump.

Construction of the indicator (a) and driving slider (b) is diagrammed in the insert. A cord from the subject's headband passes upward to a ceiling pulley (not shown), downward over pulleys (c) and (d), and then horizontally to the cord tension reel (e) located about one meter to the left. The driving slider (b), attached to the cord, moves toward (d) as the subject bends to jump; as he goes upward, it moves to the left and leaves indicator (a) at the peak of the jump. This position is read on the adjustable meter scale seen just above (a), which had previously been set so that its zero coincided with the position of (a) when the subject stood erect.

Results. With only two minor exceptions, each subject, in his average of 30 or more trials per condition, jumped higher with preliminary deep knee bends than under the control conditions, higher with preliminary stretching than with the knee bends, and higher using preliminary stationary running than with knee bends. The exceptions to this individually consistent pro-

TABLE 1

Mean Height and Variability of Jumps with Different Preliminary Exercises (N = 10, six jumps per day, five to ten days for each condition, experienced subjects.)

Measurement	A Control	B Stretching	C Stationary Running	D Knee Bends
Mean (cm)	42.95	45.10	46.31	44.19
S. D.	8.44	8.97	8.96	9.74
Diff. from control	—	2.14	3.35	1.24
% diff.	—	4.98	7.80	2.89
t ratio	—	7.97	6.25	2.88
Within-day S. D.[1]	1.83	1.91	1.93	2.08
Between-day S. D.[2]	2.11	1.49	2.13	1.98

[1]Variation of single jumps about the individual daily means.
[2]Variation of daily individual means about the individual treatment means.

gression were subject No. 2, who did 0.8 per cent higher in D than in B, and subject No. 9, who did 1.4 per cent higher in B than in C. Compared with the control, the subjects jumped 2.88 per cent higher after the deep knee bends, 4.98 per cent higher after stretching, and 7.80 per cent higher after running in place (see Table 1).

Stationary running as a preliminary exercise was 4.79 per cent more effective than knee bends (t=2.88) and 2.68 per cent more effective than stretching (t=3.25), while the latter was 2.05 per cent more effective than knee bends (t=3.55). All differences are therefore statistically significant.[3]

It may be noted that the distribution of mean scores of individual subjects per test period (200 scores in all) is normal. With treatment means equated, the Chi Square between the observed frequencies and those expected under a normal curve hypothesis (using four degrees of freedom) is only 5.41 compared with 9.49 that would be required for significance at the 5 per cent level of confidence.

Experiment 2

A more extensive sampling of naive individuals was secured. The experimental design was modified in such a way that psychological control could be secured, using Exercise D (deep knee bends). This was in principle a type of preliminary exercise used by athletes, and yet it did not have the overt appearance of obviously being connected with the jumping performance.

Method. The apparatus was the same as in Experiment I, but only five jumps per period were given so as to lessen fatigue in the unpracticed subjects (4). Fifty male university students were tested. Pretest muscular

[3]In all of these comparisons, standard small-sample statistics have been used (9, *p. 153*), with the standard error computed directly from the differences and N referring to the number of subjects, not the number of measurements. Since the same subjects were used for both experimental and control observations, the population variances for both are necessarily equal. Because S_d implicitly includes a correlation term (9, *p. 154*) which is different in the comparison of B, C, or D with the control A, it is possible for one of the differences to be larger than another and at the same time have a smaller "t" ratio, even though the sample S.D. remains constant.

Since the hypothesis being tested predicts that preliminary exercise will improve performance, comparisons of B, C, or D with A requires a one-tailed statistical test (9, *p. 60*); for N = 10 as in Experiment 1 the required "t" ratio for high significance (P = .01) is 2.82. The "t" ratios in Table 1 therefore show that all differences from the control are highly significant. Comparisons between B, C, and D discussed in the text require a two-tailed statistical test, with t = 2.26 showing significance (P = .05) and t = 3.25 showing high significance (P = .01). For the data of Table 2, where N = 50, the required "t" values are 1.68 for significance (P = .05) and 2.41 for high significance (P = .01) since a one-tailed test is involved. In comparing the data with the other studies, a two-tailed test is required and the critical "t" values become 1.99 and 2.63.

Following the precedent of other studies cited in the review, the amounts of improvement have been stated and discussed as percentage changes. Mean improvement scores in centimeters of height are given in the tables. In all cases, the "t" ratio used to assess the probability that an observed improvement might have arisen from sampling error (null hypothesis) has been computed from the increment in cm.

activity was minimized insofar as practical; for example, subjects were never tested when there had been a "work-out," or even walking more than a short distance, prior to the test.

Sitting pulse counts were taken before and after the deep knee bend exercises, and also before and after the jumping period, in order to disguise the purpose of the experiment. The subjects were told that the purpose of the tests was to compare the stress of jumping with the effect of a standard exercise on the cardiovascular system. Possibly some individuals did not believe this statement and may have guessed the true purpose of the experiment, but the writer is convinced on the basis of the questions and remarks by the subjects that nearly every one of them did accept the explanation.

Half of the subjects, randomly selected, jumped five times on their first day, *before* the preliminary exercise. On the second day's testing, approximately one week later but at the same hour, they jumped five times *after* the exercise. In order to balance out any practice effect, the order of procedure was reversed for the other half of the subjects. Re-testing was deferred if there was any evidence of muscle or joint soreness.

Results. The average height jumped without preliminary exercise was 48.12 cm; with the exercise it increased 3.27 per cent (see Table 2). The

TABLE 2

Effect of Preliminary Exercise and Practice on Height Jumped (N = 50, five jumps per day, balanced series with psychological control.)

Measurement	Control	Knee Bends	Day 1	Day 2
Mean (cm)	48.124	49.699	48.695	49.128
S. D.	7.68	7.95	7.65	7.98
Diff.	—	1.575	—	0.433
% diff.	—	3.27	—	0.89
t ratio	—	4.12	—	1.19

difference is highly significant (t=4.12). The amount of practice effect, with the groups re-arranged to balance out the influence of preliminary exercise, is small (0.89%) and is not significant (t=1.19). As before, the distribution of scores is normal within the limits of sampling error (Chi Square = 0.88).

Since there may have been some warm-up effect just from the exercise of the test jumps, it is of interest to look at only the first of the five jumps on each day. The average of the control was 47.08 cm.; preliminary exercise increased the mean height of the first jump by 3.08 per cent (t=3.17). Evidently any warm-up effect within the series was small in its influence, because the amount of gain using just the first jump was almost as large as when the averages of five jumps were used. The smaller "t" ratio has resulted from the lower reliability of single jump scores as compared with averages of five trials. Any within-series warm-up effect would presumably

have been balanced out in the experimental design that was used for the five jump comparison.

An additional statistical evaluation has been made by using the best jump of each individual in each days testing, rather than the average of his five jumps. The mean improvement from preliminary exercise estimated by using this method is 3.37 per cent, which is somewhat greater than found by using average jumps. It is a less reliable method, as previously reported by Henry (4), and the "t" ratio is only 2.67 compared with 4.12 found by using the method of averages. The poorest jump in each days testing is also higher as a result of the preliminary exercise. The improvement is 4.17 per cent (t=3.83). The mean of the control jumps is 51.36 cm. for the best jump in five, and 44.56 for the poorest jump in five, compared with 49.70 for the average jump.

The test-retest reliability coefficient has been computed by correlating the mean daily scores of each individual on Day 1 *vs.* Day 2. For the sub-group that did the preliminary exercise *before* the jumps on Day 1, r=.966, while for the subjects who did the exercise *after* the jumps on Day 1, r=.984. The geometric mean of these two, which is r=.975, is the best estimate of the reliability for the entire group of 50 subjects.

Discussion

Compared to the 1942 study of Henry (4) using the same apparatus, the mean jump of the 50 subjects (without preliminary exercise) is 0.14 cm. higher—definitely not a real difference since the "t" ratio is only 0.06. The reliability coefficient, .975, is significantly higher (19, *p. 255*) than the coefficient of *r*=.92 reported by him for five trials (t_z=3.09). This probably reflects improvement in the apparatus and a more heterogeneous sample of subjects, mostly the latter. Since the standard deviation in the Henry study was 5.31 (personal communication) compared with 7.82 cm. for the sample of Experiment 2, the observed *r*=.975 would shrink to *r*=.946 for a sample having his variability. This would no longer differ significantly from his *r*=.92. The absence of a significant practice effect when two successive days of jumping are compared is not necessarily in disagreement with Henry's recent report of learning *within* a series of seven trials on one day (5). The average jump he observed in that study also agrees with the present result within the limits of sampling error (t=0.36).[4]

Comparing Experiment 1 with Experiment 2, there is fairly good agreement. The average height jumped under the control conditions is 5.17 cm. lower for

[4]The statistical information required for comparison with the study reported in 1942 will be found in the reference cited (4). Professor Henry (who directed the present study) has supplied the figures M = 47.65, S.D. = 5.35 cm. for the average of five jumps in the 1956 study; the figures would be almost identical if estimated from the initial and final scores and intercorrelation in the published report (5). The statistical method used was the one commonly accepted for this type of comparison (10, *p. 157*).

the subjects in Experiment 1, but this difference is within the limits of sampling error ($t = 1.71$). The standard deviations are very similar ($F = 1.20$ contrasted with 2.80 required for significance at the 5 per cent level). The amounts of improvement due to the knee bend exercise do not differ significantly in the two experiments ($t = 0.58$).

The results of both experiments offer statistically acceptable evidence confirming the positive results of studies using only a few subjects, as for example the investigations of Asmussen and Boje. Evidently, preliminary exercise is valuable for activities such as jumping, as well as the "speed" type of performances that have been studied by others.

With respect to the specific nature of the preliminary exercise, the factor of stretching has been isolated in Experiment 1 and has been found to have a definite beneficial effect. A satisfactory theoretical explanation of why this isometric work should benefit performance cannot be stated at the present time. Possibly, considerable stretching is needed for optimum effectiveness, because deep knee bends were less effective than maintained tension of the elongated muscles in the specific stretching exercise. Nevertheless, the deep knee bend exercise was found to have a highly significant influence in improving jumping performance.

The superiority of stationary running as a preliminary exercise is possibly the result of the action of two factors, namely stretching and actual warming of the tissues. Of course, the amount of work, as revealed by the pulse count change, was larger than in the other exercises. Asmussen and Boje, Muido, and others cited by them, have given considerable discussion as to why increased temperature resulting from preliminary isotonic work should improve physical performance. They have found that the positive effect is greatest when the amount of preliminary work is very large. A small amount of such work, according to their curves, has only a slight influence. This may explain why some investigators have failed to secure positive results.

It must be realized that although the differences in means in the present experiment are relatively large and of high statistical significance, it cannot be expected that a single jump, or a group of jumps, preceded by the preliminary exercise will necessarily be higher than when done under the control conditions. The standard deviation of the test-retest variation within 50 individuals is 2.77 cm. for single jumps. Since the average improvement from the knee bends is 1.575 cm., one can calculate from the normal curve area that only 71 per cent of the individual single jumps would actually be higher when preceded by the preliminary exercise. Even using the average of 5 jumps per person, the mean performance of individuals would only be improved in 90 per cent of the cases because the standard error of measurement is 1.24 cm. for this method of grouping.

Summary and Conclusions

The effectiveness of several types of preliminary or warm-up exercise was determined in ten experienced subjects, each of whom performed five or

more groups of six trials of standardized vertical jumping under each of four conditions in a balanced series to control practice and conditioning. Compared with the control, preliminary deep knee bends improved performance by 2.88 per cent, isometric stretching by 4.99 per cent and stationary running by 7.80 per cent. These improvements were all statistically significant. Without exception, the mean performance of each subject was inferior in the absence of preliminary exercise. In a second experiment, the purpose of which was disguised in order to secure psychological control, a group of 50 college men showed a highly significant improvement of 3.27 per cent as a result of preliminary deep knee bends. The test-retest reliability of the average of five jumps was $r = .975$.

1. Preliminary isometric stretching exercises, as well as exercises emphasizing isotonic work, improve vertical jumping performance when used as in this experiment.

2. Within the limits investigated, increasing the amount of preliminary exercise is reflected by improved performance.

3. The Henry apparatus elicits reproducible scores and reliable individual differences in vertical jumping ability.

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Prediction of Performances on Physical Fitness Tests by Means of Somatotype Ratings

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Abstract

Scores on three fitness tests were predicted for various body types using the body components endomorphy, mesomorphy, and ectomorphy as independent variables.

All of the somatotypes found in the sample were placed in 13 categories. The 13 categories were divided, on the basis of the scores made by the various somatotypes on each of the tests, into four groups. T-score tables were constructed, for each group, for each of the four tests. The same somatotypes were not placed in the same groups for all four tests. In this respect, this method of classification differs from many others that have been suggested.

A BATTERY of four tests to measure physical fitness is included in the physical education curriculum at the State University of Iowa. This battery consists of sit-ups, pull-ups, the one-hundred yard pick-a-back run,[1] and the 300-yard shuttle run. Standard scores for each of the four tests have been determined on the basis of the performance of the male students who have participated in the basic-skills program in physical education from 1947 to 1950.

This battery of tests is important to the student since his standardized scores on the four tests are averaged and used, with other criteria, in determining his qualifications for exemption from the basic skills course. In accordance with a procedure commonly practiced in the determination of norms for fitness tests, no consideration is given to individual variations in body type.

Scoring tables have been published based upon the measurements of age, height, and weight. An example of this type of table is McCloy's Universal Scoring Tables (4). Cozens (2) stated, "Even with college men we must recognize the superiority of certain stature groups over others." On the basis of this belief, Cozens published achievement scales for nine different stature groups. Bookwalter (1) studied body build and physical performance in elementary schoolchildren using the Wetzel Grid as a means of classification. He found "indication of a fairly systematic relationship between physique channels and developmental levels according to the Wetzel Grid and the

[1]In 1954-55, this test was replaced with the one-minute squat-thrust test.

physical fitness scores of elementary school boys in Indiana." Miller (5) observed that the Cozens classification was satisfactory for grouping college men according to size, but that the classification was of no particular value in predicting performance on a seven-item test battery. He concluded, "as far as general physical performance is concerned, it seems that height and weight are unsatisfactory elements upon which to base a classification of college men."

In a study by Willgoose (9), the highest mean PFI score was attained by the mesomorph-ectomorph group, the next highest mean score by the extreme mesomorph group. He found that endomorphy was a limiting factor in respect to physical fitness. By means of a factor analysis, Sills (7) identified endomorphy and mesomorphy as factors, and found that the former was not related to the strength tests and motor tests included in his experiment. In another study, Sills and Everett (8) analyzed the relationship between dominant body types and performance on motor and strength tests. They concluded that excess weight was a handicap to the endomorphs and that insufficient strength was a handicap to the ectomorphs. The mesomorphs were superior to the other two types in all of the tests included in the study. Cureton and Hunsicker (3) found that, in general, mesomorphs and ectomesomorphs score higher on physical fitness tests than do the other somatotypes.

It did not appear from a review of the related literature that a satisfactory method had been developed for classifying male university students relative to their performance on physical fitness tests. Since the authors were of the opinion that the same standards should not be required for all students, it was the purpose of this study to determine to what extent, if at all, the standards should be based upon somatotype ratings.

Procedure

Four hundred and thirty-three University of Iowa Male freshmen served as the subjects for the study. Each subject was given the four physical fitness tests, photographed, and somatoscoped according to the method explained by Sheldon, Stevens, and Tucker in their text, *The Varieties of Human Physique* (6).

The following steps were then taken: first, multiple correlation coefficients were computed to determine the relationship between the body type components and the physical fitness tests; second, equations were computed to predict scores on each of the four tests; third, the development of a classification system with 13 categories that included all of the somatotypes in the population being studied; fourth, test scores were predicted for the somatotypes included in each category; fifth, the categories were ranked from the highest to the lowest according to the predicted scores for each of the physical-fitness tests; sixth, adjoining categories were combined, on the basis of similar scores, to reduce the classification to four groups; and seventh, 514 students were assigned to the four groups on the basis of their somatotype ratings.

T-score tables were then computed, for each of the four groups, for sit-ups, pull-ups, and the 300-yard shuttle run.

Correlations. Intercorrelations (see Table 1) for the four fitness tests and three body components were computed. The zero order correlation coefficients for the endormorphic component with each of the four fitness tests were negative; the coefficients for the mesomorphic component with each of the four fitness tests were positive; while the coefficients for the ectomorphic component with the four tests were both positive and negative. Although none of the coefficients was very high, all except two were significant at the 1 per cent level. Multiple correlation coefficients for the three somatotype components with each of the four fitness tests were determined.

TABLE 1

Zero Order Correlation Coefficients[1]

Variables	No.	1	2	3	4	5	6	7
Sit-ups	1	____						
Pull-ups	2	.2879	____					
300-yd. run	3	.2988	.4461	____				
100-yd. pick-a-back run	4	.3471	.4441	.6033	____			
Endomorphy	5	−.2716	−.4709	−.3243	−.3331	____		
Mesomorphy	6	.1892	.4258	.3223	.3917	−.2562	____	
Ectomorphy	7	−.1279	.0373	.1977	−.0264	−.2866	−.4069	____
Means		42.8	7.2	54.5	25.5	2.3	4.1	2.6
Standard Deviations		10.4	3.6	3.6	2.6	1.3	1.0	1.4

[1]E. F. Lindquist. *Statistical Analysis in Educational Research*, p. 212. For 400 subjects an *r* of .128 is significant at the 1 per cent level.

Multiple Correlations

Sit-ups	$R_{1.567} = .3464$ (6.52 P.E.est.)
Pull-ups	$R_{2.567} = .5716$ (1.98 P.E.est.)
300-yd. Run	$R_{3.567} = .4937$ (2.11 P.E.est.)
100-yd. Pick-a-Back	$R_{4.567} = .4617$ (1.54 P.E.est.)

Prediction Equations. Equations were computed to predict scores on each of the four physical fitness tests utilizing the three somatotype components as independent variables.

1. Sit-ups

$$X_0 = -2.5574\ X_1 + .1765\ X_2 - 1.6076\ X_3 + 52.3324$$

2. Pull-ups

$$X_0 = -.9580\ X_1 + 1.3112\ X_2 + .2321\ X_3 + 3.5151$$

3. 300-yd. Run

$$X_0 = +.3175\ X_1 - 1.5097\ X_2 - .8877\ X_3 + 62.261$$

4. 100-yd. Pick-a-Back

$$X_0 = +.4457\ X_1 - .8997\ X_2 - .1005\ X_3 + 28.472$$

Classification System. Sheldon (8) has suggested that "for most experiments requiring fewer categories, it would appear advisable to combine certain of the closely related somatotypes." He then presents 19 categories that might prove useful in the design of an experiment. A modification of this suggestion has been adopted for the present study. Closely related somatotypes were combined in the development of a classification system involving 13 categories.

1. Mesomorph
2. Ectomorphic mesomorph
3. Ectomorph mesomorph
4. Mesomorphic ectomorph
5. Endomorphic mesomorph
6. Moderate mesomorph
7. Endomorph mesomorph
8. Moderate ectomorph
9. Mesomorphic endomorph
10. Balanced
11. Moderate endomorph
12. Ectomorph
13. Endomorph

Prediction of Scores. The prediction equations were then used to predict the scores that the various somatotypes within each category would make on the four fitness tests. It was found that, when the somatotypes in one category had higher scores on one of the physical fitness tests than those in another category, the latter frequently had higher scores than the former on another of the physical fitness tests.

Ranking and Grouping of Categories. For each of the four physical fitness tests, the 13 categories were ranked from the highest to the lowest on the basis of the predicted scores. It was found that the same scores could be expected for many of the somatotypes in adjoining categories and, for this reason, the categories were combined into four groups. The groups included different combinations of categories, for the reason given in the preceding paragraph, for each of the physical-fitness tests. The four groups and their predicted scores, for three[2] of the physical fitness tests, are given here:

	Sit-ups
Moderate Mesomorph Mesomorph Ectomorphic Mesomorph	46-47-48-49-50
Endomorphic Mesomorph Ectomorph Mesomorph Mesomorphic Ectomorph Moderate Ectomorph	41-42-43-44-45
Moderate Endomorph Balanced Endomorph Mesomorph Ectomorph Mesomorphic Endomorph	36-37-38-39-40-41
Endomorph	33-34-35

[2]Standards for the 60-second squat-thrust test are being established to replace those for the pick-a-back test.

	Pull-ups
Ectomorphic Mesomorph Mesomorph Ectomorph Mesomorph	9-10-11
Moderate Mesomorph Endomorphic Mesomorph Mesomorphic Ectomorph	7-8-9
Ectomorph Endomorph Mesomorph Moderate Ectomorph Balanced	4-5-6
Mesomorphic Endomorph Moderate Endomorph Endomorph	1-2-3
	300-Yard Run
Ectomorphic Mesomorph Ectomorph Mesomorph Mesomorph Mesomorphic Ectomorph	51.0-52.5-54.0
Endomorphic Mesomorph Balanced Moderate Mesomorph	53.0-54.5-56.0
Ectomorph Endomorph Mesomorph Moderate Ectomorph	55.0-56.0-57.0
Mesomorphic Endomorph Moderate Endomorph Endomorph	58.0-60.0-62.0

Scoring Tables. The scores of 514 students were used to compute T-score tables for the three fitness tests. The numbers of subjects used in constructing the four T-score tables for the sit-ups test were: Group I—196, Group II—156, Group III—147, and Group IV—15; for the pull-ups test: Group I—157, Group II—160, Group III—134, and Group IV—63; for the 300-yard shuttle run: Group I—185, Group II—177, Group III—85, and Group IV—67. In order to improve the validity of the tables, additional subjects must be tested so that each of the tables will be based upon the scores of at least 500 subjects. It is much easier, as shown by the figures given, to obtain subjects for certain of the groups than for the others.

It was possible to compute T-scores for raw scores throughout the entire range of scores on two of the tables, but for the pull-ups test this was not possible for three of the four groups. These three tables were arbitrarily adjusted so that a passing score could not be given unless the subject performed at least one pull-up.

An examination of the three tables indicates that they discriminate between the members of the four groups, and that subjects of similar body builds will

be graded more fairly than would be the case if the traditional type of scoring table were to be used.

TABLE 2
Sit-ups

T-Score	Group I	Group II	Group III	Group IV
5	6	5	2	1
10	11	9	6	2
15	16	13	10	6
20	21	17	15	10
25	26	22	19	15
30	30	26	23	19
35	35	30	27	23
40	40	34	32	27
45	45	38	35	32
50	50	43	40	36
55	55	47	44	40
60	59	51	48	44
65	64	55	52	48
70	69	60	57	52
75	74	64	61	57
80	78	68	65	61
85	83	72	69	65
90	88	76	74	69
95	92	82	79	74
100	95	85	82	79

TABLE 3
Pull-ups

T-Score	Group I	Group II	Group III	Group IV
5	0	0	0	0
10	0	0	0	0
15	0	0	0	0
20	1	0	0	0
25	2	1	–	–
30	4	2	1	–
35	5	3	2	–
40	7	4	3	1
45	8	6	4	2
50	10	8	5	4
55	11	10	7	6
60	13	12	9	7
65	15	14	11	9
70	16	15	13	11
75	18	17	14	13
80	20	19	16	15
85	21	21	17	17
90	23	22	19	18
95	24	24	20	20
100	25 & over	25 & over	21 & over	21 & over

TABLE 4
300-Yard Shuttle Run

T-Score	Group I	Group II	Group III	Group IV
5	64	69	70	76.5
10	63	67	68.5	74.5
15	62	65.5	67	72.5
20	60.5	64	65.5	71
25	59	62.5	64	69
30	58	61	62.5	67
35	57	59.5	61	65
40	55.5	58	59.5	63.5
45	54.5	56	58	61.5
50	53	55	56.5	60
55	52	53	55	58
60	51	51.5	53.5	56
65	49.5	50	52	54.5
70	48	48.5	50.5	52.5
75	47	47	49	51
80	46	45.5	47.5	49
85	44.5	44	46	47
90	43.5	42.5	44.5	45.5
95	42	41	43	43.5
100	41 & under	40 & under	41.5 & under	42 & under

Summary

Four major steps were taken in the development of this study. The first was to predict scores on fitness tests by using the body components endomorphy, mesomorphy, and ectomorphy as independent variables. The second was that of establishing 13 categories into which all of the somatotypes found in the sample could be placed. In the next step the thirteen categories were divided into four groups on the basis of the scores predicted for each of the three fitness tests. And finally, T-score tables were constructed for each of the four different groups on all three of the fitness tests.

The assumption has been made that, in placing a given subject (somatotype) in a group for one of the fitness tests, the same subject may fall into another group on one or both of the other two fitness tests. For each of the three tests, therefore, different somatotypes will be grouped together according to their ability.

The multiple correlation coefficients for body build with sit-ups, pull-ups, and the 300-yard shuttle run show substantial relationships that may serve as a basis for classifying male college students into homogeneous groups, a procedure that makes it possible to grade the student in accord with others of similar ability.

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Relationship Between Measurements of Field of Motion Perception and Basketball Ability in College Men

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Abstract

Measurements of the field of motion perception of basketball players and non-basketball players were compared. Also, five basketball skill test items were administered to 101 college men, and their scores on these items and the measurements of the fields of motion perception were compared with subjectively-determined basketball ability rating scores. Measurements of the field of motion perception showed an identifiable relationship with basketball ability and, when combined with basketball test items, made a substantial contribution to the forecasting efficiency of the battery.

BASKETBALL players rely on many visual cues while playing the game. Most of these cues are received in the peripheral areas of the retina. This suggests a relationship between the ability to perceive motion in wide areas of the periphery and the ability to play basketball successfully. A study was made to explore the possibility of such relationship.

The Problem

The problem for this study was threefold: 1. To investigate the relationship between the field of motion perception and basketball ability in college men; 2. To construct a basketball skill test battery and determine its validity and forecasting efficiency; and 3. To investigate the contribution made by field of motion perception test scores to the forecasting efficiency of this basketball test.

Most tests of peripheral vision have measured visual acuity in the periphery; but in this study no attempt was made to measure graduations of acuity. The field of motion perception was considered to be that area limited by the points at which the subject could first perceive motion of a uniformly moving target while focusing straight ahead.

The perimeter has been the instrument commonly used in measuring peripheral vision. But investigation indicated that a perimeter, owing to its design for measuring the monocular field and to its detached and manually operated targets, was not a suitable instrument for use in this study.

An instrument which stabilized the subject's head while measuring his binocular field in the temporal meridian to a maximum range of 220° was used. This instrument, described in the *Instruction Manual for Driver Tests*

of the American Automobile Association (1), had two ¾ inch circular targets with alternate black and white segments. The targets were uniformly lighted and rotated automatically as they were brought into view.

Procedure

Basketball Test Items. Numerous physical educators, both men and women, have reported results of investigations of basketball skill tests. From these results, basketball test items with demonstrated validity, reliability, and administrative economy were selected and combined into a five-item basketball test. These items were:

1. A diagonal wall pass test in which the subject passed to wall targets six feet above the floor and on opposite sides of a two-foot area.
2. A jump-and-reach difference test in which the score was the number of inches difference between the subject's stand-and-reach height and his jump-and-reach height.
3. A shooting test in which the subject stood as near as he wished to the basket and shot as many baskets as he could in one minute.
4. A passing test in which the subject made as many wall passes as possible in one minute from behind a six-foot restraining line.
5. A dribbling test in which the subject dribbled up and down a 90-foot course, passing alternately to the right and left of bottles spaced 15 feet apart.

The Subjects. One hundred twenty-one college men enrolled in four sections of team sport classes were selected as subjects to take the motion perception and basketball tests. These men were systematically rated as to basketball ability by their instructors and these ratings were used as the criterion with which to compare the test scores. Of the 121 subjects, 101 took all the tests.

The motion perception test was given also to 20 aspirants to the varsity basketball team with an average of 3.8 years of high school and college basketball experience and to a contrasting group of 20 men enrolled in individual sports classes who had never played on their high school basketball teams. These groups were selected to test the hypothesis of relationship between the range of the field of motion perception and basketball ability. These same groups were retested after several weeks to check the reliability of the measuremnts.

Test Results

On the first test, the mean scores of the two groups showed differences significant at the 1 per cent level. This was interpreted as indicating a real relationship between the range of the field of motion perception and basketball ability. These measurements also indicated a biserial correlation between measurements of the field of motion perception and basketball ability of .765.

After approximately two months, measurements of the fields of motion perception for the two groups (basketball players and non-basketball players) were again taken. Scores on the retest showed no significant difference between means of the two groups but a significant difference between the means of the first and second readings of the non-basketball players. Since other investigators had found indications of improvement in peripheral vision from

training while taking a test, this improvement was attributed to that training. The failure of the basketball group to make a comparable gain suggested a greater range of improvement for subjects making low scores on the initial test.

The test and retest scores for the entire sample comprising both groups indicated a reliability coefficient of .636.

The scores of the 101 men taking all tests indicated correlation significant at the 1 per cent level between each of the five basketball test items and basketball ability. Correlation between motion perception test scores and the rating scores was significant at the 10 per cent level. The correlation for each item is shown below:

Diagonal wall pass	.602
Jump-and-reach difference	.531
Shooting	.576
Passing	.660
Dribbling	.500
Field of motion perception	.161

Intercorrelations between the basketball test items were all significant at the 1 per cent level, but the motion perception test scores failed to show significant correlation with any basketball test item.

Multiple correlation coefficients computed from Betas derived by the Doolittle method increases as basketball tests were combined. The five tests showed an R of .813. This indicated a forecasting efficiency of 41.8 which means that errors in prediction by use of the test results would be less, by 41.8 per cent, than errors made if prediction were made by chance alone.

The correlation between the criterion and the sum of raw scores for the five tests also increased as new tests were added. The sum of raw scores for the five tests showed a zero order correlation of .761 with the criterion. This indicated a forecasting efficiency of 35.1.

The increment of R was reduced substantially with the addition of each new basketball test. And after three basketball tests had been combined, the motion perception test with a zero order correlation of .161 contributed more to R as a fourth or fifth variable than basketball tests with substantially higher correlation with the criterion. As a sixth variable, the motion perception test raised R to .828 and the forecasting efficiency to 43.9.

The highest zero order coefficient of correlation between the criterion and a basketball test item was .660. The lowest was .500. These scores indicate little difficulty in finding items that show a substantial relationship with basketball ability. The chief obstacle to the construction of more precise basketball tests lies in the relatively high intercorrelation found between the basketball test items. This limiting effect of high intercorrelations suggests seeking items other than big muscle skills traditionally associated with basketball if more precise basketball tests are to be constructed.

Conclusions

The following conclusions were drawn from a study of the data:

1. The field of motion perception is a variable difficult to measure with reliability.

2. The increase in the field of motion perception attributable to training while taking the first test is greater for those subjects showing lower scores on the first test.

3. There is evidence of a real difference between the range of the field of motion perception of basketball players and non-basketball players and evidence that the range of this field is a factor contributing to basketball ability.

4. Five basketball test items used in the study were each a substantial measure of basketball ability and together constituted a valid basketball skill test.

5. High intercorrelations between the basketball skill items indicated that they tended to measure the same quality and this characteristic proved a limiting factor in the forecasting efficiency of a battery comprising them.

6. The field of motion perception test made a relatively high contribution to the forecasting efficiency of a basketball test battery.

Recommendation

The results of this study suggest that more precise basketball tests than those in present use will probably necessitate seeking items beyond the area of traditional big-muscle basketball skills. These items, while related to basketball ability, must show low intercorrelations with other basketball test items. The investigation of such variables is recommended and these investigations should include psychological and emotional factors as well as measurements of physical attributes.

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Effect of Variations of Delivery and Aim on Bowling Achievement of College Women

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Abstract

Four random groups of college women, novice to ten pin bowling, were taught under the four combinations of techniques resulting from two variations of delivery and two variations of point of aim. The variations of delivery were the hook and the straight ball, while the variations of point of aim were pin and spot. Comparisons of these instructional techniques based on the cumulative 24-game average indicate that superior results may be attained by teaching the spot point of aim to beginners regardless of the type of delivery, that beginners achieve just as good results when taught the hook ball delivery as when taught the straight ball, and that there is no interaction between type of delivery and type of aim.

THE PURPOSE of this investigation was to determine whether variations in instructional techniques of delivery and point of aim affected achievement scores in bowling.[1] The following exact hypotheses were tested:

1. There are no real differences in mean bowling scores of groups taught by four different treatments: hook ball delivery with pin aim; hook ball delivery with spot aim; straight ball delivery with pin aim; and straight ball delivery with spot aim.

2. There are no real differences in mean bowling scores resulting from variations in type of delivery.

3. There are no real differences in mean bowling scores resulting from variations in point of aim.

4. There are no real differences in mean bowling scores resulting from the interaction of type delivery and point of aim.[2]

General Procedures

Permission to conduct the research within the required physical education program during the last eight weeks of the first semester, 1955-56, was obtained from the Chairman of the Department of Physical Education for Women at Indiana University. Arrangements were made with the Chairman for bowling classes to be taught under the conditions essential to the study at 2:30 P.M. and 3:30 P.M. Monday and Wednesday, and 2:30 P.M. and

[1]This is a report of selected sections of a doctoral dissertation submitted to the School of Health, Physical Education, and Recreation, Indiana University.

[2]In the original study, each of these hypotheses was investigated at four different stages of learning. The learning stages were based on the averages for games 1-10, 11-15, 16-20, and 21-24.

3:30 P.M. Tuesday and Thursday. Selection of these four hours was based on the probability that more women would be free at these times than at other hours and the desire to have all classes meet as nearly as possible at the same time.

SELECTION OF SUBJECTS

All women electing bowling as a seasonal activity had an opportunity to participate in the study. One week before enrollment for bowling and other indoor activities, meetings were scheduled at the end of each class hour on two consecutive days.

The purpose of the meeting was explained briefly as being that of learning who would be eligible to become subjects for bowling research and who would be interested in becoming subjects. It was stated that in four classes, research would be conducted in an attempt to learn whether or not one way of teaching bowling is better than another to help beginners improve their scores. Women volunteering to aid with this research would receive the same instruction as in other bowling classes, except that each group would learn to bowl with a different combination of delivery and point of aim, to be determined by chance. No time other than class period hours would be asked of the volunteers.

It was explained that eligibility to become a subject would be dependent upon the following requirements. Subjects will have had no previous bowling instruction, will have bowled no more than five times, and will not be physical education majors. Furthermore, all volunteers must be willing and able to accept assignment to any one of four class times: 2:30 Monday-Wednesday, 3:30 Monday-Wednesday, 2:30 Tuesday-Thursday, or 3:30 Tuesday-Thursday, since class assignment would be determined by chance.

Women fulfilling the above requirements indicated their desire to become subjects by leaving their names, addresses, and telephone numbers. Eighty-six women volunteered. However, with six alleys available and two games to be bowled each period, 18 subjects for each class were considered a feasible number. Thus, the first 72 volunteers were accepted.

RANDOMIZATION OF INTERPUPIL DIFFERENCES

The randomness of groups is assumed in any experimental design involving a simple analysis of variance, and the error estimate is valid only to the extent that this assumption is met. The within-groups variance then becomes a valid estimate of chance errors arising from interpupil differences. The procedures recommended by Lindquist (2, pp. *26-28*) were followed for random assignment of subjects to groups and groups to treatments. As a result of the chance determination method of assigning groups to treatments, the 2:30 Monday-Wednesday group was assigned the hook ball delivery with spot aim, the 3:30 Monday-Wednesday group received the same delivery but with pin aim, the straight ball delivery was combined with pin aim for the 2:30 Tuesday-Thursday group, and the 3:30 Tuesday-Thursday group was

allotted the straight ball delivery and spot aim. During enrollment, the subjects were given their class hour and days.

CONTROL OF INTERGROUP DIFFERENCES

Since no estimate of errors arising from factors which vary from group to group was available, every effort was made to identify and control such factors.

The same instructor (the investigator) taught all four classes. All classes met twice a week for seven and one half weeks, and the two weekly class meetings were separated by only one day in all cases. Each subject in each class bowled two complete games at each class meeting, except the first two and the last meetings which were reserved for other purposes. The time of day was kept as constant as possible with four groups, each group meeting at either 2:30 or 3:30 in the afternoon. One of the groups under each of the variations of delivery met at 2:30 and one at 3:30; one of the groups under each of the variations of point of aim met at 2:30 and one at 3:30. The place of meeting was the same for all groups, with the same facilities, equipment, and environmental conditions existing in all cases.

The size of classes was constant at the beginning of the investigation and remained so until the end of the fourth lesson, at which time one subject was lost from the hook ball spot aim group. Two subjects were lost from the straight ball pin aim group, one at the end of the tenth lesson and one at the end of the 11th lesson. One subject was lost from the hook delivery pin aim group at the end of the 11th lesson.

The nature and content of the instruction was exactly the same for all groups. Insofar as could be determined by the investigator, except as indicated above, the only intergroup variables permitted were those concerned with the type of delivery and the point of aim.

Statistical Procedures

The procedures and formulas used in analyzing the data are those that may be found in standard statistical references. The basic references used in this study were Lindquist (2) and Edwards (1).

COLLECTION OF DATA

Subjects recorded their daily scores on the standard scoring sheets provided at the bowling alley. Each frame of each game was checked for accuracy by the investigator and daily final game scores for each subject for each game were recorded on four separate sheets, one for each group.

The cumulative 24-game average was selected as the criterion of bowling skill for purposes of comparing the achievement of groups under the different treatments at the end of the entire instruction period.

DEVELOPMENT OF ACHIEVEMENT SCORES

In a previous study, initial bowling status, determined by the first five-game average, was found to be highly related to final bowling status (3).

Thus, it was indicated that initial ability should be given consideration in evaluating final achievement.

The availability of scores for the first 24 games bowled in physical education classes by 1,505 Indiana University women, made possible the development of local norms. The beginning level, or initial status, for each of the 1,505 women was found by averaging the first five games bowled. Then, beginning levels of ability were arranged by 10-point intervals. There were seven of these ability levels, starting with the level 50-59.9 and proceeding consecutively through the level 110-119.9. For each level, the mean and standard deviation of the scores of all bowlers whose initial five-game average fell within that level, were developed for the cumulative 24-game average. T-scores were developed from these means and standard deviations for each level of ability.

The achievement scores for the experimental groups were found by first ascertaining the initial status of each subject in terms of the average of the first five games bowled during the experiment. Then, each subject's cumulative 24-game average was given a T-score by referring to the norms at the proper ability level. All subsequent statistical analyses were based on these achievement scores.

EXPERIMENTAL DESIGN

Two variations of each of two variables were studied in this investigation. Type of delivery and point of aim were the two variables concerned. The two variations of type of delivery were the straight and the hook ball; while pin and spot aim were the variations of the point of aim.

The proper experimental design to be used in studies of this kind is the two-by-two factorial design (1, *p. 208*). The advantage of this design is that more than one variable can be investigated at the same time, with information being gained not only about each variable but also about the interactions between the variables.

In this study, all tests of significance were made at the 5 per cent level of confidence. The Table of F given in Edwards (1, *pp. 410-413*) was used and, when necessary, interpolations were made for the degrees of freedom.

Analysis of the Results

The analysis of achievement scores is based on the cumulative 24-game average, which is considered to be the criterion measure.

The mean achievement scores for each of the groups under the four treatments are given in Table 1. It may be observed that there are differences existing in the mean bowling achievement scores of the four groups of women subjected to the hook and straight variations of delivery and the spot and pin variations of point of aim.

The first hypothesis to be tested is that there are no real differences in mean 24-game bowling achievement scores of groups taught by four different treatments: hook ball delivery with pin aim, hook ball delivery with spot aim, straight ball delivery with pin aim, and straight ball delivery with spot aim.

TABLE 1

Mean Bowling Achievement Scores of the Four Experimental Groups

Item	Hook delivery, pin aim	Hook delivery, spot aim	Straight delivery, pin aim	Straight delivery, spot aim
Mean achievement score	41.8	49.8	45.2	48.9
n	17	17	16	18

A summary of the analysis of the 24-game achievement scores of the four samples, or groups, is presented in Table 2.

TABLE 2

Summary of the Analysis of Variance Applied to the Bowling Achievement Scores of the Four Experimental Groups

Source of variation	Sum of squares	d.f.	Variance	F
Between groups	683.196	3	227.732	2.033
Within groups	7167.745	64	111.996	
Total	7850.941	67		

The degrees of freedom for the between groups variance is equal to r (number of groups) minus 1, or 4—1 = 3; and for the within groups variance, N (total number of scores) minus *r*, or 68—4=64.

The obtained F is 2.033. From the Table of F (1, *pp. 410-413*), it is found that with 3° and 64° of freedom, F must be equal to or exceed 2.757 for significance at the 5 per cent level of confidence. Since the obtained F fails to meet this criterion, the hypothesis is retained. It can be assumed that the four groups are samples from the same population and that no differences occur among the means, variances, or a combination of means and variances except those caused by chance.

Since homogeneity of variance has been demonstrated by the non-significant F, thus meeting one requirement basic to insuring validity of the results, an analysis for each of the remaining three hypotheses can be undertaken.

The mean achievement scores of the groups treated under the two variations of each of the two variables are given in Table 3.

TABLE 3

Mean Bowling Achievement Scores of the Groups Treated Under the Two Variations of Each of the Two Variables

Item	Hook delivery	Straight delivery	Pin point of aim	Spot point of aim
Mean achievement score	45.8	47.1	43.5	49.3
n	34	34	33	35

It can be observed from Table 3 that there is a difference in the means of groups taught under the two variations of delivery, with the straight delivery group having the higher mean. Table 3 also reveals that there is a difference in the means of groups taught under the two variations of point of aim, with the group taught by the spot point of aim having the higher mean. The subsequent statistical analysis tests the significance of these differences.

The between-groups sum of squares (683.196 given in Table 2) is partitioned into its three component parts, and each component is analyzed in order to examine the appropriate hypothesis.

The next hypothesis to be tested is that there is no real difference between the mean 24-game achievement scores of the two groups taught by the hook and the straight ball deliveries.

The analysis of variance following the partitioning of the between groups sum of squares is given in Table 4.

TABLE 4

Summary of the Analysis of Variance Resulting From Partitioning the Sum of Squares Between Groups for the Bowling Achievement Scores

Source of variation	Sum of squares	d.f.	Variance	F
Variable 1, delivery	31.118	1	31.118	.278
Variable 2, point of aim	583.217	1	583.217	5.207
Interaction, delivery vs. aim	68.861	1	68.861	.615
Within groups	7167.745	64	111.996	
Total	7850.941	67		

With 1° and 64° of freedom, F must be at least as large as 3.997 to be significant at the 5 per cent level of confidence. By referring to Table 4, it can be observed that the obtained F is .278, which is far below the value needed for significance. Therefore, the hypothesis that no real difference exists between the mean 24-game achievement scores of the two groups taught the hook and straight ball deliveries is tenable. When only the type of delivery is considered, teaching a group to bowl the hook ball or the straight ball produces no statistically significant difference in cumulative 24-game achievement scores. Neither delivery can be said to be superior to the other insofar as the results of this investigation are concerned.

The next analysis tests specifically the hypothesis that there is no real difference between the mean 24-game achievement scores of two groups, the one taught pin aim and the other taught spot aim.

Reference to Table 4 indicates that the obtained F is 5.207. With 1° and 64° of freedom, the criterion value of significance, at the 5 per cent level, is 3.997. Since the obtained F exceeds this value, the hypothesis is rejected

at the 5 per cent level of confidence. It can be concluded that there is a real difference between the means of the groups taught to bowl with pin aim and spot aim. From an inspection of Table 3, the mean for the group taught to bowl with spot aim can be found to be 49.3; while that for the group taught to bowl at pins is 43.5. It is thus possible to conclude that the spot type of aim is superior to the pin type for developing final bowling achievement, as measured by the cumulative 24-game average. This conclusion is, of course, based on the assumption that all intergroup factors which might have affected bowling achievement as measured, were reasonably well controlled.

The final hypothesis to be tested is that there is no interaction between the two variables—type of delivery and type of aim. When interaction occurs, it signifies that the response of the subjects on the criterion measure to the variations of one variable are significantly affected by the variations of the second variable.

Table 5 presents the means and the difference between means for type of delivery and point of aim based on the cumulative 24-game average.

TABLE 5

Means and Differences Between Means for Type of Delivery and Point of Aim

Variable 2, Point of aim	Variable 1, Delivery		Difference
	Hook	Straight	
Pin	41.8	45.2	−3.4
Spot	49.8	48.9	.9
Difference	−8.0	−3.7	−4.3

It may be seen, by referring to Table 5, that when taught by the hook ball delivery, there is a difference between the means of the pin and spot point of aim groups of 8.0 When taught under the straight ball delivery, there is a difference between the means of the pin and spot point of aim groups of 3.7. The following statistical analysis will demonstrate the probability of whether or not these differences in the point of aim groups are unlike simply because of chance factors or because of the variation in the type of delivery. The analysis will attempt to answer the same question relative to the differences observed in the hook and straight delivery groups taught under the two points of aim.

A summary of the results of this analysis can be found by referring to Table 4. With 1° and 64° of freedom, F would need to be at least as large as 3.997 to be significant at the 5 per cent level of confidence. Since the obtained F (.615) is considerably less than the criterion value, the hypothesis that there is no interaction between the two variables is retained. It may then be concluded that, within the limitations of this investigation, any difference in bowling achievement resulting from the two variations of point of aim will be the same, except for chance variations, regardless of whether

the hook delivery or the straight delivery is taught. It may also be concluded that any difference in bowling achievement resulting from the two variations in type of delivery will be the same, except for chance variations, regardless of whether the pin or spot point of aim is taught.

Conclusions

It may be concluded from the results of the analysis of the bowling achievement scores based on the cumulative 24-game average that:

1. There are no real differences in achievement scores of groups taught under the four treatments: hook delivery and pin aim; hook delivery and spot aim; straight delivery and pin aim; straight delivery and spot aim.

2. There is no real difference in achievement scores of groups taught under the two variations of type of delivery—the hook ball and the straight ball deliveries.

3. There is a significant difference in achievement scores of groups taught under the two variations of point of aim—the pin aim and spot aim. The mean difference favors the group taught under the spot point of aim.

4. There is no interaction between the two variables—type of delivery and point of aim.

These conclusions indicate that superior results may be attained by teaching the spot point of aim to beginners, regardless of the type of delivery that is taught. They also indicate that beginners achieve just as good results when taught the hook ball delivery as when taught the straight ball delivery. Since the majority of advanced and champion bowlers favor the hook ball delivery, it would seem reasonable that this type of delivery should be taught immediately to beginners.

REFERENCES

1. Edwards, Allen L. *Experimental Design in Psychological Research.* New York: Rinehart and Co., Inc., 1950. 446 pp.
2. Lindquist, E. F. *Statistical Analysis in Educational Research.* Boston: Houghton Mifflin Co., 1940. 266 pp.
3. Phillips, Marjorie, and Dean Summers, "Bowling Norms and Learning Curves for College Women," *Research Quarterly,* **21**: 377-385, Dec. 1950.

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Notes & Comments

NOTES

Relationship Between Maximum Isometric Tension and Maximum Isotonic Elbow Flexion

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CLARKE and Herman[1] have called attention to the difficulty of determining the proper load to be used when progressive resistance exercises are employed for therapeutic purposes and have examined the validity of isometric strength measurements in expressing isotonic strength. Under laboratory conditions, strength testing is usually done by means of strain gauges or other methods which are essentially isometric. Strength is usually developed, however, by means of exercises with dumbbells or by other methods which are isometric. The purpose of this study was to determine the relationship between the tension which can be exerted by trained subjects in a single maximum isometric elbow contraction and the maximum weight which can be moved in a single isotonic elbow flexion.

Twenty-four male students at the College of Osteopathic Physicians and Surgeons were trained with progressive resistance unilateral curls and presses for a period of six weeks. During this time they exercised with dumbbells three days a week. To avoid introducing bias by the use of the favored hand alone, half of the subjects trained using their right arm and half using their left arm. At the end of the training period, the amount of tension which could be recorded in a single maximum isometric contraction, as recorded on a strain gauge, and the amount of weight which could be handled in a single maximum dumbbell curl were ascertained. Every effort was made to see that the subject was in the same position during the two tests and no assistive movements of the body were permitted. It was found that the subjects could exert a mean isometric tension of 43.2 pounds, with a standard deviation of 3.4 pounds, and a mean maximum isotonic contraction of 41.8 pounds, with a standard deviation of 6.9 pounds. The difference of 1.4 pounds between the two means was of no statistical significance. So far as trained male subjects are concerned, there appears to be no great difference between the amount of tension which may be recorded in a single maximum isometric elbow contraction and the amount of weight which may be handled in a single maximum isotonic elbow flexion.

It appears from this study that the determination of the proper load for a single repetition maximum elbow flexion can be made with considerable accuracy by use of a strain gauge. The data suggest that measurements of maximum strength made by the use of isometric techniques are valid in expressing isometric strength.

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[1]David H. Clarke and Edward L. Herman, "Objective Determination of Resistance Load for Ten Repetitions Maximum for Quadriceps Development," *Research Quarterly*, 26: 385-390, Dec. 1955.

Research Abstracts

Prepared by the Research Abstracts Committee of the National Council of the Research Section, PAUL A. HUNSICKER, Chairman

Anatomy and Physiology

1. CONRAD, M. C., AND A. T. MILLER, JR. Age changes in body size, body composition and basal metabolism. *Am. J. Physiology*, **186**: 207 (Aug. 1956).

The interrelations of body size, composition and basal metabolism were reported in a study on 69 albino rats 18-17 days in age.

Sex differences in body composition and metabolism were not consistent in direction. The general trend showed an early rise in metabolic rate up to 30 days, a rapid decline 30-60 days and a gradual decline thereafter. The rapid decline during the immediate post-weaning period has been confirmed in other studies, but the significance is uncertain. The body size increase between 30-120 days might cause the decline in metabolism per body weight.

The differences in body composition of 30, 60 and 120 day old rats showed increases with age with respect to inert fat and ash. A decrease of extra cellular fluid, metabolically inert, was found so that the proportion of active tissue mass showed no significant change between 30-120 days of age. There was a decrease in relative weight of the liver, brain, heart, and kidneys, which have high metabolic rates.—*E. D. Michael.*

2. DEMYER, WILLIAM. Methods and advantages of random sampling in the census of nerve fibers and other histological elements. *Anatomical Record*, **125**: (July 1956).

Estimation of population totals by random sampling is superior in accuracy and efficiency to the census methods in common use by neurohistologists. Population totals based on random sampling have predictable and adjustable accuracy. From simple mathematical relationships, the number of samples necessary to count in any sampling problem can be calculated in advance, and counting can be concluded as soon as acceptable accurate population estimates are obtained. The simple statistical formulae for exploiting random sampling are given and their use illustrated by numerical examples. Methods for locating random samples in histologic sections are described. These methods employ an ocular reticle alone or in combination with other grid systems such as the graduated stage of the microscope, a grid system projected from a lantern slide, and a micrometer grid locator simply and inexpensively made from two machinist's micrometers. The latter device has greater flexibility and efficiency than the other methods and can be used directly to sample areas ranging from 0.1 mm^2 to 6.25 cm^2. Areas larger than 6.25 cm^2 require preliminary subdivision. In neuroanatomy the procedures described will be useful to derive normal value of nerve fiber and neuron populations for statistical comparison with values obtained from experimental or pathological material.—*Wistar Institute.*

3. GARN, STANLEY MARION. Fat thickness and growth progress during infancy. *Human Biology*, **28**: 2:232-249 (May 1956).

The relationship between the thickness of the subcutaneous fat on the left lower leg, and size and growth progress in infancy was investigated in over 300 clinically healthy, presumably full-term infants at 1, 3, 6, 9, and 12 months of age. Comparing lean and fat infants, the latter were significantly longer at one month, but not thereafter. The same general trend was observed in tibial shaft length (extent of calcification along the diaphysis), whereas for muscle breadth the two groups did not show any consistent difference. The initially leanest and initially fattest were markedly different at one month,

but tended to converge and become indistinguishable thereafter. The early and transient size superiority of the fatter infants at one month was shown to be a holdover from their superior size and developmental advancement at birth. There was no evidence that the fatter infants were consistently more robust or faster growing, thereby questioning the use of subcutaneous fat as a measure of nutritional status in healthy infants during the first year of life.—*D. B. Van Dalen.*

4. Gersten, Jerome W. Relation of ultrasound effects to the orientation of tendon in the ultrasound field. *Arch. Physic. Med. and Rehab.*, **37**: 201-209 (April 1956).

A tendon, placed in vitro, parallel to an ultrasound field exhibited a reversible increase in water content and an irreversible increase in extensibility. No change in the temperature of the tendon was noticed.—*Peter V. Karpovich.*

5. Goodman, Carol E., Alma J. Murphy, and James W. Rae. Tissue temperature produced by the application of moist air. *Arch. Physic. Med. and Rehab.*, **37**: 18-22 (Jan. 1956).

Various parts of the body were heated in a cabinet containing moist air of 44.4° C. Body and tissue temperatures were recorded during and after 30 minutes of heating. Skin temperature varied from 40.9° to 42.3°, muscle temperature at 1.5 cm. of depth, 36.0° to 39.1° and at 3 cm. of depth 35.7° to 38.2°, rectal temperature 37.1° to 38.6°.—*Peter V. Karpovich.*

6. Grant, R., H. D. Henatsch, and G. Sted. Tonic and phasic ventral horn cells differentiated by post-tetanic potentiation in cat extensors. *Acta Physiol. Scand.*, **37**: 114-126 (Sept. 1956).

The purpose of this study was to determine whether the potentiated (tetanized by stimulating electrodes) motoneurones which subserve tonic or postural motor behavior are different from those that initiate phasic responses. This was determined by the stretch reflex to the muscle afferents and the behavior of 100 potentiated ventral horn cells was studied in ten cats.

The results showed that in the potentiated state the motoneurones respond to a constant 10 mm. stretch by (1) tonic reflexes which fire for a long time in maintained stretch, and (2) phasic ones which fire once or twice on the rising phase of the stretch, in spite of any facilitated state. This difference in response between tonic and phasic ventral horn cells was also observed after decortication of the anterior lobe of the cerebellum.—*C. Etta Walters.*

7. Hellebrandt, F. A., Sara Jane Houtz, Miriam J. Partridge, and C. Etta Walters. Tonic neck reflexes in exercises of stress in man. *Am. J. Physical Medicine*, **35**: 144-159 (June 1956).

The purpose of this study was to observe movement patterns evoked under stress and to test their usefulness as an aid to neuromuscular training of the handicapped. Exercise was performed on a Hellebrandt-Kelso ergograph and consisted of wrist flexion and extension performed unilaterally and bilaterally. The head was observed in the spontaneously assumed position, in ipsilateral or contralateral rotation, and in ventral and dorsal flexion. Stress was imposed by gradually increasing the resistance or by overloading at the onset of the exercise and continuing to exhaustion. Action potentials were picked up by surface electrodes and recorded on an 8-channel Offner, ink writing Crystograph. The major muscles studied were the prime movers of the wrist, elbow, shoulder joints, and head.

The results demonstrated that exercise is not confined to an anatomical prime mover. The pattern elicited under stress is an orderly and coordinated one which increases under stress and becomes more invariable with fatigue. The exercising limb affects the contralateral antagonist first and then its counterpart as stress becomes greater. Strong voluntary head movements in the direction of the spontaneously assumed ones augment work output, whereas reverse movements have an inhibitory effect. The exercising limb exerts

a tonic reflex effect upon the neck muscles which modifies the position of the head autonomously, this in turn expedites performance of the exercising limb and provides the rationale for making use of the tonic neck reflex in the rehabilitation of the disabled.—*C. Etta Walters.*

8. Henry, F. M., and Janice C. DeMoor. Lactic and alactic oxygen consumption in moderate exercise of graded intensity. *Journal of Applied Physiology*, **8**: 608-613 (May 1956).

Oxygen debt progressed from 0.2 to 4.1 l. as work varied in eight steps from 0.21 to 2.1 l/min. O_2 requirement. Since debts at the higher loads were larger than income lag during exercise, the O_2 requirement cannot be estimated accurately from steady-state income even though the work is submaximal. Equations involving the sum of the exponential components a_1e^{-k1t} and a_2e^{-k2t} describe the rise of O_2 intake during exercise, the decline during O_2 debt pay-off and the influence of a 10-fold variation in work load on the parameters. Blood lactate data reported by others for moderate exercise support identification of the second component as lactate oxidation. Its velocity constant k_2 seems to be related to blood flow; it increases three-fold during exercise compared with recovery, but becomes slower as work load is increased. The velocity constant k_1 governs the oxidation of alactic debt; it is stable as work load is varied.—*Paul Hunsicker.*

9. Kurlander, Arnold B., Sidney Abraham, and J. Wallace Rion. Obesity and disease. *Human Biology*, **28**: 2: 203-211 (May 1956).

The study is based upon 643 Negroes who applied to the admitting and emergency office for hospital or out-patient care in Washington, D. C. Obesity was defined by four criteria, ranging from measures which tended to include all body components (e.g., body fat, bone, muscle) to those which tended to include only body fat. The prevalence of heart disease and hypertension was compared in obese and normal or "thin" persons. For males, when measures of obesity which tended to include only body fat (i.e., skinfold thickness) were used, there was no relationship between heart disease and obesity. When measures of obesity which included other body components were used, there was a pronounced relationship between heart disease and obesity. In females, about the same relationship between heart disease and obesity and between hypertension and obesity was observed regardless of the measures of obesity used.—*D. B. Van Dalen.*

10. Lehmann, Justus F., Edward J. Baldes, and Frank H. Krusen. Effects of ultrasound of high intensity on cellular structures. *Arch. Physic. and Rehab.*, **37**: 90-95 (Feb. 1956).

Exposure of roots of onions to ultrasonic intensities of 110 watts per sq. cm. for five minutes caused central destruction of the root.—*Peter V. Karpovich.*

11. Macy, Icie G., and Harriet J. Kelly. Body composition in childhood. *Human Biology*, **28**: 3: 289-308 (Sept. 1956).

The values for body composition of healthy living children were acquired by biological determinations, anthropometric measurements, skeletal maturation assessments, and physiologic functional tests. The observations were made on the same subjects during childhood. The methodologies selected gave the following average percentages of the major constituents of body weight for the period of childhood: total body water 55% (extracellular water, 20%; intracellular water, 35%); fat, 25% lean body mass, 75%. The average specific gravity for childhood was 1.005.—*D. B. Van Dalen.*

12. Morris, Edwin David, and David Burns Moffat. Abnormal origin of the basilar artery from the cervical port of the internal carotid and its embryological significance. *Anat. Rec.*, **125**: (Aug. 1956).

In a 67-year-old male subject, the basilar artery arose as a branch of the internal carotid artery 1.3 cm below the level of the transverse process of the atlas and entered the skull through the hypoglossal canal, lateral to the hypoglossal nerve. In the posterior

cranial fossa it was joined by the two small vertebral arteries, of which the right had a normal origin and course whilst the left arose from the arch of the aorta and entered the foramen transversarium of the fifth cervical vertebra. The brachal plexus was post-fixed. Comparison with the three similar cases previously described in the literature and a study of the embryology of the vessels of this region suggest that the anolalous vessel has three components. The vessel represents in sequence the hypoglossal artery, part of the lateral anastomotic channel (primitive lateral basilo-vertebral anastomosis of Padget) and a persistent communication between the lateral channel and the cerebral vertebral artery.—*Wistar Institute.*

13. Newman, Katherine Jane, and Howard Voas Meredith. Individual growth in skeletal bigonial diameter during the childhood period from 5 to 11 years of age. *American Journal of Anatomy*, **99**: July 1956.

The subjects were 72 North American white children. The source for measures of bigonial diameter was posteroanterior roentgenograms of the head and face. Measures were converted to data for skeletal bigonial diameter by correcting for roentgenographic enlargement and blurring. Highly valid records were obtained on 36 males at semi-annual intervals between ages 5 and 11 years and on 36 females at annual intervals over the same age span.

It is found that during the second six-year period of human ontogeny: (1) the mean curve for skeletal bigonial diameter is a negatively accelerated increasing function of age, (2) the series of means on each sex is represented adequately by a parabolic equation, (3) trends for individuals largely constitute a graded series from oblique rectilinear curves to rising curves moderately concave to the base line, (4) the course of growth in individuals is a smooth on-going process with no irregularities other than can be accounted for as random error, (5) there is a systematic tendency for absolute and relative increments of growth to be greater in males than in females, (6) a low positive association exists between growth in bigonial diameter and growth in bizygomatic diameter, and (7) the relation between growth in biparietal diameter and growth in bigonial diameter does not differ appreciably from zero.—*Wistar Institute.*

14. Sacks, Jacob, and Jo H. Morton. Lactic and pyruvic acid relations in contracting mammalian muscle. *Am. J. Physiology*, **186**: 221 (Aug. 1956).

Experiments on cats under pentobarbital anesthesia were carried out concerning the gastrocnemius muscle under anaerobic tetanic contraction conditions.

There was an increase in pyruvic acid content as well as lactic acid content with relatively smaller pyruvic acid increase. The ratio of pyruvic to lactic was reduced to one-half the value in resting muscle. When the muscles were contracted under steady state conditions with adequate oxygen supply, there was only slight pyruvic acid increase.

It would appear that pyruvic acid in contrast to lactic acid shows little tendency to escape from the muscle. The high post-exercise blood pyruvic acid values indicate that pyruvic acid accumulation took place before the increased oxygen supply and after the initial phase of activity. The suggestion that post work increased in blood pyruvate represents oxidative removal of lactic acid and that the oxygen debt can be divided into lactic acid removal and alactacid portion was not verified here.—*E. D. Michael.*

15. Strong, Leon Henri. Muscle fibers of the tongue functional in consonant production. *Anatomical Rec.*, **126**: Sept. 1956.

When all the palatograms of the palatodental series of consonants used in English are superimposed, the area of palatal contact has the shape of a horseshoe. Certain heavy diagonal muscle bundles which extend from the septum of the tongue to the aponeurosis of the dorsum, together with the verticales of their region, frame a set of vectors which can deform the dorsum, near or continuous with the margin, into a peripheral linear elevation co-apted to the lingual dental surfaces and to the palate. Such bundles are present from the molar to the canine area of the tongue. In front of the filiform exten-

sion of the septum, a hitherto undescribed or illustrated configuration of muscle bundles pass from the lateral region of the dorsum and decussate through the center to the lateral region of the inferior surface of the opposite side. Contraction of these latter bundles will deform the tongue from one canine region of the tongue to the opposite side into an arched peripheral elevation. This arch thus connects the two linear peripheral elevations into a horseshoe-shaped mass.

By specific innervation of the bundles constituting any part or parts of this elevation, a corresponding deformation will appear on the dorsum of the tongue. Hence, it will make its impression on the palate and teeth above.—*Wistar Institute.*

16. White, Robert M. Body build and body weight in 25-year-old army men. *Human Biology*, **28**: 2: 141-145. (May 1956).

An analysis of weight and body build was carried out on a series of approximately 3550 25-year-old white army separatees. For each inch of stature, mean weights were presented for small, medium, and large groupings of chest breath and bi-iliac diameter. The weights presented were those for definite categories of body size as determined by the use of chest breadth and bi-iliac diameters. The weights shown in Metropolitan Life Insurance tables were for categories of body size in which the determination of the size of the frame is not specified or defined in terms of any body diameter.—*D. B. Van Dalen.*

17. Yamaguchi, Bin. Some physical peculiarities of deaf-mute boys. *Human Biology*, **28**: 309-315. (Sept. 1956).

Physique and motor functions of 58 deaf mute Japanese boys were compared with normal boys. It was found that the body form of deaf-mutes resembles that of persons whose metabolic rates are somewhat lower and thus approaches the feminine type. This seems to be a result of metabolic retardation caused by the generally sedentary nature of deaf-mute life. Motor functions are generally lower. There is a lack of development of the motor function, especially of functional right-left differentiation.—*D. B. Van Dalen.*

Health Education

18. Ant, M. New medical treatment for peptic ulcers, including a review of medical literature, *New York Physician & American Medicine*, **47**: Nov. 1956.

An analysis of 195 case histories of gastric or duodenal ulcer treated with Rabro tablets for three to 12 weeks showed clinical benefit in 179 cases (92%) and X-ray improvement in 160 of 186 roentgenologically studied cases (86%). The results in ambulatory cases were almost as satisfactory as for bed patients. The advantages of this treatment were prompt relief of the symptoms in less than a week, relief of spasm as well as of gastric hyperacidity, and roentgenological healing of the ulcer niches in most cases. Rabro tablets contain glycyrrhiza extract of standardized glycyrrhizin content compounded with light magnesium carbonate, bismuth subnitrate and sodium bicarbonate as antacids, plus small amounts of frangula and calamus to offset the constipating effects of bismuth. Apparently, glycyrrhiza relieves gastroduodenal spasm and thereby contributes to the natural healing of gastric and duodenal ulcers. The foreign literature on use of Rabro tablets in peptic ulcer is reviewed.—*M. Ant.*

19. Corliss, L. M., M.D., and Virginia Breed, audiometrist. Analysis of hearing tests in the Denver public schools. *Journal of School Health*, **26**: 5 (May 1956).

In any school hearing program, it is necessary to make periodic analysis of test results to evaluate testing procedures. About 23,000 students were tested. Tests should be made each year, but this is impractical. Majority of hearing defects develop during elementary school years. The individual pure-tone audiometry is a satisfactory testing method. It is suggested that evaluation of testing procedures be checked periodically.—*Joseph E. Lantagne.*

20. Furcolow, Micheal L., M.D. On the usefulness of tuberculin skin test. *American Journal of Public Health*, **46**: 9 (Sept. 1956).

There has been much confusion in the minds of many physicians about the usefulness of tuberculin testing and many concepts. This research indicates that the tuberculin test, to be useful, must be specific. Persons with tuberculosis are hypersensitive to tuberculin.

The knowledge obtained from tuberculin tests is of value to the community and to the health department in comparing local rates of infection with other areas. Uniform testing of schoolchildren with a uniform dosage of tuberculin appears to be a satisfactory means of comparing tuberculin sensitivity in various areas.—*Joseph E. Lantagne.*

Nutrition

21. Bronner, Felix, Robert S. Harris, Constantine J. Maletskos, and Clemens E. Benda. Studies in calcium metabolism. Effect of food phytates on calcium^{45} uptake in boys on a moderate calcium breakfast. *Journal of Nutrition*, **59**: July 1956.

The effect of phytates on Ca^{45} uptake was studied in 17 boys, aged 9.5 to 15.5 years, who were institutionalized because of subnormal intelligence. The boys were divided into two groups in a criss-cross design. Each group received each of two test breakfasts three weeks apart. The breakfasts consisted of either oatmeal or farina and 220 ml of milk, part of which served as the vehicle for 0.85μc Ca^{45}. The breakfasts had an average Ca content of 239 mg, and a phytic P content of 80 and 0 mg, respectively. The contents of Ca and phytic P of these breakfasts are considered typical of the breakfasts of American children.

In contrast with an earlier study in which low amounts of Ca were given (*J. Nutr.*, **54**: 523, 1954), no statistically significant depression of Ca^{45} uptake was observed in the serum, nor was there a significant difference in the Ca^{45} output in either the urine or the feces of the two diet groups. It is concluded that phytate does not exert a significant effect on Ca^{45} uptake when the meal provides as much as 240 mg of Ca and when the intake of phytic P in oatmeal is 80 mg. A comparison of these results with those of the earlier study (*loc. cit.*) revealed that the percentage of absorbed Ca decrease as the intake of Ca increases.—*Wistar Institute.*

22. Committee on Nutritional Anthropometry of the Food and Nutritional Board of the National Research Council. Recommendations concerning body measurements for the characterization of nutritional status. *Human Biology*, **28**: 2: 111-123 (May 1956).

The above-named committee suggested suitable standards for selected items of measurement to evaluate the nutritional status of man with regard to emaciation, obesity, growth, and skeletal and muscular development.—*D. B. Van Dalen.*

23. Crampton, Earle Wilcox, Robert Haddon Common, Ernest Thackeray Pritchard, and Florence Amelia Farmer. Studies to determine the nature of the damage to the nutritive value of some vegetable oils from heat treatment. *Journal Nutrition*, **60**: Sept. 1956.

In previous studies in this laboratory, linseed oil was heated at 275° C. in a current of carbon dioxide. The ethyl esters of the polymerized oil were separated into a "non-distillable" and a "distillable" fraction. The "distillable" fraction was further fractionated by urea into an adduct-forming "distillable" fraction (AFD) and a non-adduct-forming "distillable" fraction (NAFD). The NAFD fraction was toxic to young rats; the AFD fraction was harmless. This paper presents the results of rat feeding trials conducted with AFD and NAFD fractions prepared from heated soybean oil and heated sunflower seed oil. The NAFD fraction from heated soybean oil was toxic, though to a lesser degree than that from heated linseed oil. The NAFD fraction from heated sunflower seed oil was only slightly injurious. The AFD fractions from both oils were harmless nutritionally. The chief chemical differences between the NAFD fractions from the three heated

oils were in respect of their behavior on alkali-isomerization. The NAFD from heated linseed oil displayed relatively little increase of its absorbance at 233 mμ, whereas the results for the NAFD fraction from soybean and sunflower seed oils suggested the presence of high proportions of difficulty conjugable diene unsaturation, as shown by the increase in absorbance at 233 mμ on extending the time of alkali-isomerization from 25 minutes to 6 hours. The results suggest that linseed NAFD may contain a high proportion of non-conjugable diene *cis*-isomers, possibly of cyclic structure.—*Wistar Institute.*

24. Perez, Carlos, M.D., *et al.* Endemic goiter in Costa Rican school children. *American Journal of Public Health*, **46**: 10 (Oct. 1956).

Recent studies in Costa Rica have revealed a relatively high incidence of endemic goiter and have stimulated legislation for compulsory iodization of salt. Over 26,000 were examined both in rural and in urban areas. The lowest incidence was 10% and the highest was 25+%. The school-age population averaged about 16.5% having goiter.—*Joseph E. Lantagne.*

25. Roderuck, Charlotte, Cecelia Pudelkewicz, Emil Henry Jebe, and Ercel Sherman Eppright. Serum vitamin C of Iowa school children and its relationship to diet and age, *Journal of Nutrition*, **59**: July 1956.

Seven-day dietary records and blood serum vitamin C concentrations were obtained from about 650 Iowa school children in a survey carried out from 1949 to 1951. Decreasing concentrations of vitamin C in the serum (except for girls over 14 years of age) and decreasing intakes of vitamin C per kilogram body weight were associated with increasing age. From 15 years of age, the concentration of vitamin C in the blood serum of girls increased although there was no comparable change in intake. More children over 12 years of age than under 12 years of age were classified as poor or fair in respect to their vitamin C status according to the categories suggested by Bessey and Lowry. The calculated intake of vitamin C from vitamin C-rich foods only was as good as total vitamin C intake for predicting blood serum concentrations of this nutrient; intake per kilogram body weight was a somewhat better predicator of serum concentrations than was total intake per day. Neither measure of intake could be used as a precise predictor of vitamin C concentration in the serum. Mean intakes of vitamin C similar to the Recommended Allowances of the National Research Council were associated with mean serum concentrations lower than 0.8 mg in children beyond 11 or 12 years of age.—*Wistar Institute.*

Psychology

26. Fleishman, Edwin A., and Walter E. Hempel, Jr. Factorial analysis of complex psychomotor performance and related skills. *Journal of Applied Psychology*, **40**: 96-104 (April 1956).

In an effort to gain more insight and secure leads about the possible organization of abilities in the psychomotor area, 23 variables were analyzed using the centroid method. Sixteen of the variables were apparatus psychomotor tests and seven were printed tests. The printed tests were used to see if they might possibly substitute for some of the apparatus tests. Attention was called to the fact that Roff had analyzed the same data using an oblique factor solution.

Nine of the ten factors extracted were identified. Four of the factors were composed of appartus tests; one Psychomotor Coordination factor with adjustments in restricted movements, one Psychomotor Coordination factor with grosser movements and several body parts moving simultaneously, a Manual Dexterity factor which helped clarify the Air Force Psychomotor Precision factor, and a Rate Control factor. Four of the factors were composed of both apparatus tests and printed tests: an Integration factor, two Spatial Relations factors, and a Visualization factor separated from the spatial Relations factors in previous studies. One factor, Perceptual Speed, was made up of only printed tests.

It was concluded that a wide variety of different psychomotor tasks could be accounted for by broad group factors of psychomotor skill rather than just by narrow, highly specific motor skills; that in general some printed tests could be used to sample psychomotor factors; and that some factors not covered by other tests are sampled only by psychomotor tests.—*Frances Z. Cumbee.*

27. Guilford, J. P. The structure of intellect. *Psychological Bulletin*, **53**: 267-293 (July 1956).

A description of the structure of adult, human intellect in terms of factors seems valuable. From approximately 40 known factors, not only is an outline of a system strongly suggested, but it would also have implications for factor theory, for psychological theory, and for the concept of intelligence and intelligence testing. Vacancies that appear in any such structure would suggest unknown factors which might exist. Such a structure would also make possible a greater scope and variety of investigations concerning the qualities and functions of the intellect.

The 40 factors are divided into two classes, thinking and memory, with only seven memory factors. Further subclasses of the thinking class are Cognitive (discovery) Factors, Production (convergent thinking and divergent thinking) Factors, and Evaluation Factors. For these classes and subclasses, five matrices are produced which differentiate columns by content (figural, structural, conceptual), and rows by: (1) kind of thing discovered in Cognitive Factors—fundamentals, classes, relations patterns or systems, problem, implications; (2) kind of thing produced in Convergent Thinking—names, correlates, orders, changes, unique conclusions; (3) kind of thing produced in Divergent Thinking—words, ideas, expressions, shifts, novel responses; (4) no differentiation by rows in Evaluation Factors since this domain has not been as well explored; (5) kind of thing remembered in Memory Factors—associative connections, content, span.—*Frances Z. Cumbee.*

28. Herber, Rick F. The relation of intelligence and physical maturity to social status of children. *Journal of Educational Psychology*, **47**: 3: 158-162 (March 1956).

Three classes of school children, one class from each of the third, fourth, and fifth grades from a public school in a small suburban town, constituted the group studied. The children were both rural and urban, from predominately middle-income homes. Ninety-seven children made up the sample. It was found that physical maturity as measured by height showed no relation to social status in pre-adolescent children. Children who showed considerable deviation in I. Q. from the group also deviated in social status in the same direction as the I. Q. deviation.—*D. B. Van Dalen.*

29. Patterson, Franklin, editor. Youth as citizens: A study of adolescent self-direction and social responsibility. *Journal of Educational Sociology*, **30**: 41-112 (Oct. 1956).

This entire issue is devoted to a report of the Youth Community Participation Project at New York University, a one-year pilot study completed in June, 1956, to study the achievement of freedom and significance by youth in community life. No summary is possible here, but this issue presents some very valuable data from a highly significant project. The titles of the articles indicate their nature: "General Characteristics of Participating Youth Groups," "Adult Role in Adolescent Subculture Innovation: A Case Study," "Group Efforts Toward Self-Government and Social Responsibility," "The Community and the Self-Governing Adolescent Group," and "Is Society the Patient? Research and Action Implications."—*Bruce L. Bennett.*

30. Schafer, Arnold Edward, *et al.* Absorption of topically applied vitamins. *J. Nutrition*, **59**: 2 (June 1956).

The effectiveness of topical absorption of several B complex vitamins and vitamin D was studied by use of various ointments on the skin of rats. Body weight gain and urinary

excretion were used as the indexes of transfer for the B complex vitamins and the degree of calcification or rachitic bone for vitamin D. Weanling rats were fed diets deficient in the vitamin under test and shaved in the scapular region to expose approximately 2 cm^2 of skin. Ten milligrams of the fortified ointments were rubbed into the shaved area twice per week. In general the ointments contained the dosages of the vitamin tested equal to and twice that administered orally. During the period of skin absorption (two hours) the ats were confined in a tight fitted wire enclosure to prevent oral access to the ointment. After the absorption interval the area of application was thoroughly washed. On the basis of the criteria used it is apparent that several B complex vitamins and vitamin D are rapidly and efficiently absorbed and utilized when applied to topical preparations. As vehicles for skin transfer of vitamins a vanillin solution and a plastocozed hydrocarbon water absorbing gel ointment were found to be especially effective.—*The Wistar Institute.*

31. Symonds, Percival M. A research checklist in educational psychology. *Journal of Educational Psychology*, **47**: 2: 100-109 (Feb. 1956).

The checklist of questions which constituted the body of this paper was derived from questions raised by students in seminar courses in contemporary educational psychology at Teachers College, Columbia University. This checklist may serve as an inventory of the kinds of tissues that arise in planning a research study. Although specifically designed for educational psychology, it could be of value to students in health, physical education, and recreation and to instructors in research methods courses as an outline of various issues which might be presented in such a course.—*D. B. Van Dalen.*

32. Walker, Warren, Eleanor Botha, and Lewis Barbato. The psychiatric interview and teacher training. *Mental Hygiene*, **40**: 406-12 (July 1956).

Physical and psychiatric evaluation of 582 students in education was made at the University of Denver for a two-year period. The evaluation was required of all students in their junior year. Each student was interviewed by a psychiatrist following the administration of the Thematic Apperception Test.

Most students seemed well motivated for teaching. Some seemed primarily interested in subject material rather than teaching, and a large number of physical education majors appeared to have a primary interest in a specific sport in which they excelled and were trying to find a way to put this to use.

The authors believe that the university psychiatrist should not serve as a screening agent to weed out undesirable individuals for teaching. They recommend that prospective teachers should take a basic course in mental hygiene and then have a psychiatric interview the following quarter.—*Bruce L. Bennett.*

33. Wegner, Norma, and David Zeaman. Team and individual performances on a motor learning task. *Journal of General Psychology*, **55**: 127-142 (July 1956).

Seventy-six college students performed the ordinary pursuit rotor task as individuals, in teams of two, and in teams of four to investigate the performance of teams as well as individuals. All subjects received a pre-training period in order to achieve a standard minimum performance. There were two training sessions, spaced at least one week apart. It was found that, throughout learning, the larger the team, the better the performance and the greater the variability. High positive transfer occurred after change from team to alone conditions and alone to team conditions. The authors briefly discussed possible reasons for the results.—*Bruce L. Bennett.*

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